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NEW FLORIDA AGARICS

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Of the white-spored species at Gainesville, *Amanita solitaria* is an abundant example, occurring everywhere in many forms. *A. phalloides* is likewise common, as is *A. rubescens,* but *A. muscaria* and *A. Caesarea* are rare. The newcomer will at once mistake *Amanitopsis pubescens* for *A. cothurnata* and find to his surprise that it has no ring at all and a very short boot. Both the yellow and the red chantrelle are abundant; *Lactaria* and *Russula* occur in bewildering array; *Armillaria mellea* and *Clitocybe illudens* dislike the heat, while *Clitocybe tabescens* thrives on it; and the green-spored *Lepiota* comes out in countless flocks, to the despair of the mycophagist.

The winter visitor is sure to find *Laccaria laccata, Pleurotus ostreatus, Tricholoma sejunctum, T. personatum, Pluteus cervinus,* a few species of *Cortinarius* and *Hebeloma,* plenty of the bitter *Hypholoma fasciculare,* and lots of the tough, wood-loving forms like *Lentinus* and *Marasmius.* But he must wait for warm weather if he wishes to see the beautiful *Tricholoma Russula, Phylloporus rhodoxanthus, Hypholoma lacrymabundum* and *Stropharia bilamellata,* this last being more common on our lawns than is *Agaricus campester.*

In introducing the following novelties, I wish to acknowledge the assistance of Mr. Erdman West, Mycologist of the Florida Agricultural Experiment Station, in the microscopic examination of spores and to say that all the specimens cited are deposited in the herbarium of this Station.

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Venenarius abruptiformis sp. nov.

Pileo 10 cm. lato, albo; lamellis latis; sporis glabris, 11–12 × 5.5 μ; stipite fibrilloso, 8 × 1.5–2.5 cm.; annulo amplo, persistente; volva cupuliformi, magna, truncata, 3 cm. lata et alta.

Pileus convex to expanded, gregarious, about 10 cm. broad; surface dry, white, avellaneous-isabelline on the disk, decorated with small flat volval fragments; context white, unchanging, taste and odor not characteristic, without a trace of chloride of lime; lamellae broad, white, rounded behind, changing to dark-isabelline on drying; spores oblong-ellipsoid, flat on the inside, hyaline, smooth, 11–12 × 5.5–7 μ; stipe white, fibrillose, glabrous above the annulus, equal or slightly tapering upward from an enormous bulb, not at all radicate, about 8 × 1.5–2.5 cm.; annulus ample, apical, white, entire, persistent, simple or duplex at the margin; volva firm, cup-shaped, evenly truncate at the top, white, rarely purplish below, 3 cm. or more wide and high.

Type collected by W. A. Murrill under a hedge of Japanese shining privet in Gainesville, Fla., August 9–23, 1937 (No. *16048*). All stages were observed as the sporophores appeared day after day from the wide-spread mycelium. The species is one of the most striking and clean-cut in this outstanding genus. From *A. abrupta* Peck it is easily distinguished by the absence of pointed warts, the fibrillose stipe, and the non-striate margin. The bulb, however, is of the same shape in both plants, and quite different from that of *A. virosa,* which moreover has globose spores.

Lactaria alachuana sp. nov.

Pileo subumbonato, 5–7.5 cm. lato, glabro, roseo-avellaneo vel subfulvo; lacte alba, piperata; lamellis concoloribus; sporis gobosis, echinulatis, 7 μ; stipite concolore, glabro, 3 × 1–1.5 cm.

Pileus convex to expanding, with slight umbo, gregarious, 5–7.5 cm. broad; surface moist, smooth, glabrous, uniformly rosy-isabelline to pale-fulvous, margin entire; context whitish, unchanging; latex white, darkening a little after long exposure, moderately acrid; lamellae adnate or adnexed, several times inserted, of medium width, rather crowded, pale rosy-isabelline, darker some time after bruising; spores globose, roughly echinulate, hyaline, about 7 μ; stipe short, thick, hollow, smooth, glabrous, subequal, rosy-isabelline, about 3 × 1–1.5 cm.

Type collected by W. A. Murrill in leaf-mold under an ever-

green oak in a hammock south of Newnan's Lake, Alachua Co., Fla., Jan. 9, 1938 (No. *16021*). Also collected by me in a similar situation near Gainesville a few days later (No. *16018*). A neat, cool-weather species, practically unicolorous, loving low, moist, shaded places. It reminds me of the poisonous *L. rufa* as I saw it in Sweden, only it is paler above and not yellowish on the gills.

Lactaria nonlactiflua sp. nov.

Pileo 4–5 cm. lato, glabro, subcinereo vel roseo-isabellino; odore et sapore grato; lamellis vulneratis rubescentibus; sporis globosis, echinulatis, 7 μ; stipite concolore, glabro, 5 × 0.5–0.7 cm.

Pileus convex to expanding, gregarious to cespitose, about 4–5 cm. broad; surface smooth, glabrous, slightly moist, pale grayish or pale rosy-isabelline, margin even, entire; context rather light and spongy, pallid, odor pleasant, taste nutty; latex wanting; lamellae pallid, short-decurrent, moderately close, rather narrow, entire, pallid, becoming pale reddish-brown when bruised; spores typical for the genus, globose, roughly echinulate, hyaline, about 7 μ; stipe concolorous, equal, smooth, dry, glabrous, about 5 cm. long and 5–7 mm. thick.

Type collected by W. A. Murrill under evergreen oaks at Gainesville, Fla., Jan. 12, 1938 (No. *16038*). Also collected by the author the next day under another evergreen oak (No. *16039*). Suggestive of *Lepista tarda* until I found the spore-print absolutely white. Hymenophores young and healthy, but even young cows have been known to go dry.

Lactaria praeseriflua sp. nov.

Pileo convexo-depresso, 5–6 cm. lato, tomentuloso, cremeo, vulnerato brunnescente; lacte copiosa, grata, alba, immutabili; sporis subglobosis, asperulatis, 7 × 6 μ; stipite albo, tomentuloso, 4–5 × 1.5–2 cm.

Pileus convex to expanded or somewhat depressed, gregarious, about 5–6 cm. broad; surface smooth, dry, minutely tomentose; uniformly pale yellowish, becoming brownish when bruised; context white, pallid or reddish in dried specimens; latex very abundant, watery-white like whey, sweet, unchanging; lamellae adnexed, not often inserted, rather narrow and crowded, whitish, brownish in dried specimens; spores subglobose, rough, hyaline, about 7 × 6 μ; stipe short, subequal, smooth, white, finely tomentose, solid or stuffed, about 4–5 × 1.5–2 cm.

Type collected by W. A. Murrill under an evergreen oak in Gainesville, Fla., Aug. 17, 1937 (No. *16020*). Also collected by the author under a live-oak in Gainesville, Aug. 9, 1937 (No. *16019*); in woods at Gainesville, Sept. 19, 1932 (No. *F9468*); under oaks a few miles west of Gainesville, Aug. 16, 1937 (No. *16011*); and by West and Murrill in woods, Sept. 16, 1932 (No. *F9473*). This species loves hot, rainy weather, when it usually appears in abundance under oaks. The sweet milk is remarkably copious and resembles whey, so I have applied the popular name, "Whey Lactaria." Another distinguishing character is the fine tomentum which densely covers both cap and stem.

Russula alachuana sp. nov.

Pileo 9 cm. lato, purpureo et cinereo-flavo; sapore grato; sporis globosis vel subglobosis, 6 μ; stipite pulverulento, subroseo, 5 $\times$ 2 cm.

Pileus convex to slightly depressed, about 9 cm. broad; surface dry, minutely velvety, the cuticle separating into granular scales, purple mixed with grayish-yellow, not peeling readily; context white, taste mild; lamellae adnate, equal, a few forking at the base, white, of medium width and distance, pale brownish in dried specimens; spores white, globose or subglobose, rough, about 6 μ; stipe equal, smooth, pulverulent, pale roseous, stuffed to hollow, about 5 $\times$ 2 cm.

Type collected by W. A. Murrill on a lawn under an oak in Gainesville, Fla., Oct. 5, 1932 (No. *F9510*). This is a large, handsome species and I hope to find more of it.

Russula emeticiformis sp. nov.

Pileo 6 cm. lato, glabro, viscido, purpureo, centro fuligineo; sapore piperato; sporis globosis, echinulatis, 7 μ; stipite albo, glabro, 5 $\times$ 0.6–0.8 cm.

Pileus convex to expanded, about 6 cm. broad; surface smooth, glabrous, viscid, purple, blackish on the disk, pellicle separable only at the margin, which is even, entire, concolorous; context white, strongly acrid at once; lamellae adnate, crowded, some furcate, white, brownish in dried specimens; spores globose, roughly echinulate, about 7 μ; stipe equal or enlarged below, smooth, glabrous, white, solid, about 5 cm. long and 6–8 mm. thick.

Type collected by W. A. Murrill in the humus of a rotten log in oak woods at Gainesville, Fla., Dec. 28, 1932 (No. *F9535*).

Strongly suggestive of *R. emetica* but differing in several ways, as the description will show.

Russula lepidiformis sp. nov.

Pileo convexo-plano, 4–5 cm. lato, glabro, subflavido, centro roseo, carne amara, non piperata; sporis globosis, asperulatis, 7 μ; stipite glabro, albo, 4–5 × 1 cm.

Pileus convex to plane, firm, drying almost without a wrinkle, 4–5 cm. broad; surface smooth, dry, glabrous, subflavous, pink on the disk, margin even, entire, pellicle not readily separable; context white, decidedly bitterish though not acrid; lamellae milk-white, becoming pale brownish in dried specimens, adnate, equal, narrow, crowded; spores globose, rough, 7 μ; stipe equal, dry, smooth, glabrous, milk-white, about 4–5 × 1 cm.

Type collected by W. A. Murrill on the ground in turkey oak woods at Gainesville, Fla., Aug. 8, 1937 (No. *16012*). If it were not for the decidedly unpleasant taste I might try to assign this plant to *R. lepida*. However, one should not be surprised at anything he finds under turkey oaks in Florida.

Russula subochroleuca sp. nov.

Pileo convexo-depresso, 9 cm. lato, glabro, albo et cremeo; carne amara et piperata; lamellis albis, vulneratis melleo-ochraceis; sporis globosis, 7–9.5 μ; stipite glabro, albo, 5 × 2.5–3.5 cm.

Pileus convex to depressed, solitary, reaching 9 cm. broad; surface dry, smooth, glabrous, white varied with cremeous, not peeling, margin even, upturned in age; context firm, white, unchanging, acrid and bitterish at once; lamellae adnate with decurrent tooth, ventricose, rather crowded, many forking halfway, not fragile, white, becoming melleous-ochraceous where bruised; spores globose, not verrucose but undulate, very pale ochraceous, 7–9.5 μ; stipe large, heavy, solid or stuffed, tapering downward, smooth, white, glabrous, about 5 × 2.5–3.5 cm.

Type collected by W. A. Murrill in sandy, grassy soil in an open grove of young pines and laurel oaks at Gainesville, Fla., October 17, 1932 (No. *F9566*). A splendid species having the general form of *R. nigricans* but with pleasing white and yellowish tints that are retained on drying.

Russula subochrophylla sp. nov.

Pileo 4–6 cm. lato, glabro, rubro; sapore grata; lamellis albis dein ochraceis; sporis ochraceis, verrucosis, 8.5–11 × 6–8.5 μ; stipite albo, glabro, 4–5 × 1–1.5 cm.

Pileus convex to slightly depressed, gregarious, 4–6 cm. broad; surface smooth, dry, glabrous, red, incarnate toward the margin, which is even and entire; context white, sweet, nutty, edible; lamellae adnate, equal or a few furcate, broad, crowded, white when young but soon ochraceous; spores plainly ochraceous in mass, broadly ellipsoid, roughly verrucose, slightly ochraceous under the microscope, 8.5–11 × 6–8.5 μ; stipe equal, smooth, glabrous, white, about 4–5 × 1–1.5 cm.

Type collected by W. A. Murrill on the ground in loblolly pine woods at Gainesville, Fla., September 26, 1932 (No. *F9516*). Also collected by the author in the same place, Nov. 18, 1932 (No. *F9534*); and again ten days later (No. *F9532*). When first seen it was pushing up under the mats of pine needles in abundance, and I enjoyed eating it at various times during that winter. Since then it has occurred rather sparingly. Of course I assigned it promptly to *R. ochrophylla* but later, under a more critical examination, it seemed to differ in its small size, crowded gills, red instead of purple color, always white stem, and preference for pines rather than oaks. It is a common plant here and I find these characters very constant. The spores will distinguish it at once.

Hygrophorus eburneiformis sp. nov.

Pileo albo, viscido, umbonato, 6 cm. lato; sapore grato; lamellis sinuatis; sporis 7–8.5 × 5 μ; stipite viscido, albo, 4 × 1–2 cm.

Hymenophores dazzling white and slimy-viscid on surface and stipe, gregarious; pileus convex, umbonate, to expanded and irregular, reaching 6 cm. broad; surface smooth, margin undulate to lobed; context thin, white, unchanging, mild; lamellae sinuate, moderately broad and distant, interveined, entire; spores ovoid or broadly ellipsoid, smooth, hyaline, 7–8.5 × 5 μ; stipe subequal, smooth, glabrous, with satiny sheen, hollow, about 4 × 1–2 cm.

Type collected by W. A. Murrill in leaf-mold under a magnolia in a hammock south of Newnan's Lake, Alachua Co., Fla., January 9, 1938 (No. *16030*). *H. eburneus* may be at once distinguished by its decurrent gills.

Melanoleuca alachuana sp. nov.

Pileo convexo-plano, 2.5–4 cm. lato, viscido, albo vel isabellino, centro subfuliginoso, carne valde farinacea; stipite glabro, albo, viscido, 5–6 × 2–4 cm.

Pileus convex to plane, gregarious to subcespitose, 2.5–4 cm. broad; surface viscid, white or isabelline, pale fuliginous on the disk, margin entire, concolorous; context white, unchanging, both odor and taste strongly farinaceous; lamellae slightly adnexed, rounded behind, medium distant, broad, entire, white; spores not examined; stipe white, equal, smooth, glabrous, viscid except at the apex, about 5–6 cm. long and 2–4 mm. thick.

Type collected by W. A. Murrill on a partly shaded lawn in Gainesville, Fla., Sept. 18, 1932 (No. *F9856*). Also collected by the author under a live-oak in Gainesville, Aug. 12, 1937 (No. *16031*). A viscid species suggesting *M. resplendens* and also certain species of *Hygrophorus*.

Melanoleuca citrinifolia sp. nov.

Pileo 5 cm. lato, glabro, roseo-isabellino; carne amara; lamellis citrinis; stipite subglabro, citrino, 5–7 × 0.5–0.7 cm.

Pileus convex to subexpanded, solitary, 5 cm. broad; surface dry, smooth, glabrous, uniformly pale rosy-isabelline, margin entire, concolorous; context white, taste bitter; lamellae sinuate-adnexed, rather narrow and crowded, lemon-yellow, entire on the edges; spores not examined; stipe equal, smooth, subglabrous, lemon-yellow, about 5–7 cm. long and 5–7 mm. thick.

Type collected by W. A. Murrill on the ground in woods at Gainesville, Fla., Feb. 5, 1929 (No. *F9860*). Very pretty and distinct, not suggesting to me any of our northern species. It is evidently very rare.

Gymnopus albistrictus sp. nov.

Pileo 4 cm. lato, semper albo, glabro; sapore grato; sporis 5–6 × 3–3.5 μ; stipite albo, glabro, 5–6 cm. alto.

Pileus convex to subexpanded, cespitose, about 4 cm. broad; surface smooth, dry, glabrous, white; context white, thin, taste mild; lamellae adnexed, crowded, white, denticulate; spores ovoid, smooth, hyaline, uniguttulate, 5–6 × 3–3.5 μ; stipe slender, white, rarely yellowish at the base, smooth, glabrous, enlarged below, 5–6 cm. long.

Type collected by W. A. Murrill under an evergreen oak at Gainesville, Fla., Jan. 12, 1938 (No. *16024*). Also collected by Erdman West and W. A. Murrill in similar localities at Gainesville in October and November, 1932 (Nos. *F9861* and *F9849*). Resembling *G. strictipes* in form but always white. No doubt derived from *G. nummularius* Fries, but now fixed in its new environment as a distinct entity.

Gymnopus atroviolaceus sp. nov.

Pileo 2–4 cm. lato, glabro, atro-violaceo; sapore grato; lamellis sinuatis, violaceis; sporis 5 × 3 μ; stipite glabro, violaceo, 6 × 0.5 cm.

Pileus convex to subexpanded, solitary, 2–4 cm. broad; surface moist, smooth, glabrous, opaque, dark violaceous, margin not striate, thin, entire, concolorous, incurved on drying; context white with a lilac tint, unchanging, with pleasant taste and no odor; lamellae sinuate, three or four times inserted, crowded, entire, violaceous; spores ovoid or ellipsoid, smooth, hyaline, about 5 × 3 μ; cystidia none; stipe cartilaginous, equal, smooth, glabrous, violaceous, shining, about 6 cm. long and 5 mm. or less thick.

Type collected by Erdman West and W. A. Murrill among decaying chips under broad-leaved trees at Gainesville, Fla., November 3, 1932 (*F9846*). A very beautiful species, dark violet above and violet below, suggesting *Mycena pelianthina*, with which it might be associated generically.

Gymnopus butyraceus trichopus (Pers.) comb. nov.

Pileus convex to subexpanded, solitary, about 7–8 cm. broad; surface smooth, glabrous, uniformly fulvous, margin entire to undulate, concolorous, inflexed on drying; context thin, pallid; lamellae adnate, narrow, much crowded, pallid to pale fulvous, beautifully denticulate on the edges; spores ellipsoid, smooth, pale-buff, 6.5–7.5 × 3.5–4 μ; stipe cartilaginous, tapering upward, smooth, hollow, covered entirely with a dense, whitish, short tomentum, 5 cm. long, 1–2 cm. thick, somewhat flattened and grooved on drying.

Collected by the author at the edge of a rotten log under an oak at Gainesville, Fla., August 16, 1937 (No. *16023*). A large specimen characterized by crowded, narrow, denticulate gills and a tomentose stipe. It is very distinct from the form of *G. dryophilus* found here.

Gymnopus lilacinus (Coker) comb. nov.

Pileus convex to expanded, at length depressed, gregarious to cespitose, reaching 8 cm. broad; surface dry, glabrous, smooth to rugose, pale-isabelline, darker at the center, margin becoming irregular and often cracked; context thin, pallid, sweet and nutty; lamellae adnate or adnexed and rounded behind, pallid, entire, much twisted on drying; spores broadly ellipsoid, smooth, hyaline, about $7 \times 5\ \mu$; cystidia spiny and knobby, hyaline, projecting about $20\ \mu$; stipe long, slender, twisted, equal, smooth, glabrous, hollow, white or pallid, 8–12 cm. long and 5–8 mm. thick.

Collected by the author in abundance under live-oaks at Gainesville, Fla., Aug. 2, 1937 (No. *16025*). Described and given a manuscript name before Dr. Coker's publication was noticed. My brief notes only confirm his excellent description.

Prunulus subinclinatus sp. nov.

Pileis gregaribus vel subcaespitosis, 3–5 cm. latis, glabris, radiato-sulcatis, cervinis vel subbrunneis, centro obscuriore; sapore farinaceo; stipite glabro, albo, 6–10 cm. alto.

Pileus convex to expanded, scattered or gregarious, not densely cespitose, about 3–5 cm. broad; surface glabrous, radiate-sulcate and rugose, fawn-colored to dull watery-brown, darker on the umbo; context white, taste farinaceous, lamellae almost free, white, broad, entire; spores not examined; stipe slender, equal, hollow, smooth, glabrous, white, whitish-mycelioid below, 6–10 cm. long.

Type collected by Erdman West and W. A. Murrill on a dead oak log in woods at Gainesville, Fla., November 9, 1932 (No. *F15708*). Also collected in similar situations in November and December, 1932 (*F15692, F15693, F15709* and *F15695*). A fine species, abundant at times on oak logs, suggesting *M. galericulata* and *M. inclinata*.

Pleuropus roseiavellaneus sp. nov.

Pileo convexo, 5 cm. lato, roseo-avellaneo, glabro; sapore farinaceo, non amaro; lamellis subconcoloribus; sporis subroseis, $8\text{–}9 \times 5\text{–}6\ \mu$; stipite glabro, bulboso, 6×1 cm.

Hymenophores dull rosy-avellaneous throughout, paler on the hymenium and within, brownish when bruised, gregarious; pileus convex, not fully expanding, about 5 cm. or less broad; surface

smooth, glabrous; context fragrant, farinaceous, not bitter; lamellae adnate to short-decurrent, medium distant; spores ovoid, smooth, pale-pink, 8–9 × 5–6 μ; stipe smooth, glabrous, bulbous, solid, about 6 cm. long and scarcely 1 cm. thick.

Type collected by W. A. Murrill under live-oaks in Gainesville, Fla., Aug. 12, 1937 (No. *16032*). Also collected by me near the type locality under a live-oak, Aug. 7, 1937 (No. *16022*). Probably nearest to *Pleuropus abortivus.*

Volvariopsis canalipes sp. nov.

Pileo convexo, 6–8 cm. lato, albo, sicco, glabro, non striato; sporis 15.5–18 × 9.5–11 μ; stipite albo, canaliculati, 4 cm. alto; volva magna, alba.

Pileus convex, solitary, about 6–8 cm. broad; surface smooth, white, dry, glabrous, decorated with large fragments of the volva, margin not striate; context white, with pleasant odor; lamellae free, crowded, ventricose, white to pink; spores oblong-ellipsoid, smooth, pink, 15.5–18 × 9.5–11 μ; stipe white, tapering upward, very short, less than 4 cm., distinctly and closely furrowed for its entire length; volva large, white, cup-like, shallow, with ragged edges.

Type collected by W. A. Murrill on a sandy, exposed railway embankment at Green Cove Springs, Fla., March 3, 1926 (No. *F9975*). A similar plant had been observed by me on the Golf Links there in 1925 but I was too much engaged at the time to collect it. Considering my score, I wish I had. This species is remarkable for its grooved stem. The furrows are deep, straight, close, exactly parallel, with sharp edges, reminding me of those found in some boletes, but without the cross connections. Nothing like this Corinthian touch has been recorded for our American species of this genus. In other characters the plant resembles *V. speciosa,* but it is not viscid and has a much shorter stem.

Volvariopsis floridana sp. nov.

Pileo 8–10 cm. lato, glabro, avellaneo; sporis 15–17 × 7–8 μ; stipite albo, glabro, 5–10 × 1–2 cm.; volva alba, 2 cm. alta et 3 cm. lata.

Pileus convex to plane, gregarious, 8–10 cm. broad; surface glabrous, moist but not viscid except after a rain, entirely smooth and usually uniformly avellaneous but occasionally subfuliginous on the disk, always adorned with several large patches of the rup-

tured volva, margin fertile, never striate; context white, unchanging, taste and odor pleasant; lamellae free or slightly adnexed, rounded behind, ventricose, crowded, several times inserted, white to pink, edges uneven; spores oblong-ellipsoid, smooth, pink, 15–17 × 7–8 μ; stipe milk-white, smooth, glabrous, tapering upward, solid, white within, unchanging, 5–10 × 1–2 cm.; volva white, broad, shallow, lobed, always covered with sand, about 2 cm. high and 3 cm. wide.

Type collected by Glenn Steckel and W. A. Murrill on an exposed sandy slope in Gainesville, Fla., January 17–21, 1938 (No. *16046*). Also collected by W. A. Murrill on a bank in Gainesville, Mar. 9, 1927 (No. *F9970*), and on an exposed bank in Gainesville, January 13, 1938 (No. *16047*). When I first saw this plant I was strongly reminded of *Pluteus cervinus*. It had been wet by a rain and was somewhat viscid and fuliginous on the disk. All specimens collected later, however, were avellaneous to dark-avellaneous and not viscid. By observing a large group over a period of several days every stage in the development was accurately recorded. Although several gray squirrels were about, none of the plants were touched by them, which was sufficient warning for me. The nearest relative of this species is *V. alabamensis*, of which it may be only a light-colored variety, but, if so, a very constant one.

Cortinarius praebrevipes sp. nov.

Pileo convexo-plano, 5–7.5 cm. lato, pallido vel isabellino, viscido; sapore valde amaro; lamellis atro-violaceis, adnexis; sporis verrucosis, 8.5–9.5 × 6–7 μ; stipite violaceo, glabro, bulboso, 2 cm. alto et 2–2.5 cm. crasso.

Pileus convex to expanded, not umbonate, gregarious to cespitose, 5–7.5 cm. broad; surface pallid to isabelline, viscid, smooth, glabrous, margin entire, incurved; context pallid, decidedly bitter; lamellae dark-violet when young, soon dirty-brown and at length rusty from the spores, adnexed, rather narrow, crowded, entire; spores subglobose to pyriform, prominently verrucose, ferruginous, uniguttulate, 8.5–9.5 × 6–7 μ; stipe exceedingly short, at first violet, smooth, glabrous, becoming isabelline when bruised, arising from a large margined bulb, about 2 cm. long and 2–2.5 cm. thick; cortina slight, hyaline, evanescent.

Type collected by W. A. Murrill in shaded soil at Gainesville, Fla., Aug. 23, 1937 (No. *16003*). Also collected by the author later in the same day on a lawn under oaks at Gainesville (No.

15880). Remarkable for its very short stipe. The spores are also rather peculiar and the flesh decidedly bitter. I was surprised to find the spore-print tinted with rose, as in *Lepista,* although the species plainly belongs in *Cortinarius.*

Cortinarius subcommunis sp. nov.

Pileo 5 cm. lato, glabro, subviscido, pallide roseo-avellaneo; sapore grato; sporis verrucosis, 9.5–12 × 6 μ; stipite pallido, subglabro, 5–7 × 0.6–0.8 cm.

Pileus convex to plane, not umbonate, gregarious, about 5 cm. broad; surface smooth, slightly viscid, glabrous, whitish with a rosy-isabelline tint, margin even, entire; context thin, whitish, nutty, odor not characteristic; lamellae adnate, medium broad, rather crowded, soon colored ferruginous to fulvous by the spores, entire on the edges; spores ovoid to ellipsoid, plainly verrucose, uniguttulate at times, ferruginous, 9.5–12 × 6 μ; stipe concolorous, equal, except somewhat enlarged at the base, smooth, subglabrous, stuffed, about 5–7 cm. long and 6–8 mm. thick; cortina slight, fibrillose, evanescent.

Type collected by W. A. Murrill on the ground under a live-oak at Gainesville, Fla., Jan. 13, 1938 (No. *16044*). Also collected by the author the same day under another live-oak (No. *16045*). On first seeing it, I thought of *Hebeloma albidulum* Peck but remarked in my notes that it would make a better *Cortinarius,* which guess was confirmed when the spores were examined.

Hebeloma praefarinaceum sp. nov.

Pileo convexo-plano, subumbonato, glabro, cremeo vel pallide rubro-brunneo; carne valde farinacea; lamellis albis isabellescentibus; sporis ochraceis, 11–13 × 5–6 μ; stipite glabro, albo, 5 × 1 cm.

Pileus convex to plane, broadly umbonate at times, somewhat irregular, gregarious, about 6–7 cm. broad; surface slightly viscid when wet, smooth, glabrous, uniformly cremeous to pale reddish-brown; context white, unchanging, with strongly farinaceous odor and taste; lamellae adnexed, broad, ventricose, moderately distant, entire on the edges, white when young, becoming isabelline; spores oblong-ellipsoid, flat on the inside, smooth, uniguttulate, ochraceous with a ferruginous tint, 11–13 × 5–6 μ; stipe equal, smooth, glabrous, milk-white, hollow, about 5 × 1 cm.

Type collected by W. A. Murrill under an evergreen oak in Gainesville, Fla., Jan. 14, 1938 (No. *16033*). The pronounced

farinaceous odor and taste, even in dried specimens, are very characteristic.

Pluteolus floridanus sp. nov.

Pileo 2.5 cm. lato, viscido, striato, albo, centro cremeo; sporis ferrugineis, 13–15.5 × 7–8.5 μ; stipite albo, glabro, 8 cm. alto.

Pileus convex to plane, not umbonate, solitary, about 2.5 cm. broad; surface viscid, striate, white, smooth and cremeous on the disk, margin splitting and becoming discolored with age; context thin, white, fragile; lamellae free, narrow, crowded, entire, soon ferruginous, much wrinkled and folded on drying; spores ellipsoid, slightly smaller at one end, smooth ferruginous, rarely guttulate, 13–15.5 × 7–8.5 μ; stipe long, slender, hollow, tapering upward from a clavate base, smooth, glabrous, white, shining, about 8 cm. long.

Type collected by W. A. Murrill in rich, open soil among weeds at Gainesville, Fla., Jan. 13, 1938 (No. *15939*). The species in this genus run pretty close together but I cannot seem to make this plant fit any of them. When these rare and perishable forms are better known I am sure they can be more logically arranged.

NEW COMBINATIONS

For those using Saccardo's nomenclature the following new combinations are made:

Gymnopus albistrictus = **Collybia albistricta**
Gymnopus atroviolaceus = **Collybia atroviolacea**
Melanoleuca alachuana = **Tricholoma alachuanum**
Melanoleuca citrinifolia = **Tricholoma citrinifolium**
Pleuropus roseiavellaneus = **Clitopilus roseiavellaneus**
Prunulus subinclinatus = **Mycena subinclinata**
Venenarius abruptiformis = **Amanita abruptiformis**
Volvariopsis canalipes = **Volvaria canalipes**
Volvariopsis floridana = **Volvaria floridana**

GAINESVILLE, FLA.

FURTHER NOTES ON CANTHARELLUS MULTIPLEX

P. F. Shope

(with 1 figure)

This fungus was first described by Underwood in 1899 (**3**) from type material collected in Maine. Thirty-eight years passed before there appeared in the literature a report of a second collection of this species, this time coming from Canada (**1**). During the summer of 1936 Mrs. P. F. Shope collected this fungus in Colorado from the forest floor of an Engelman spruce forest, Middle Boulder Canyon, elevation 10,500 feet. It is of interest to note that the collections so far known indicate a boreal distribution.

Underwood's scientific description (*l. c.*) was drawn from dried specimens sent him by the collector Mrs. Elizabeth W. Woodworth. The collector supplied a photograph and some field notes which are included in the article. These field notes report among other things that the fungus is from 6 to 12 inches high, but on making measurements of the type material, and allowing for shrinkage on drying, it is apparent that it never attained that height. A height of from 5 to 6 inches would be better. Furthermore, an illustration of one of the Canadian collections (*l. c.*) shows a maximum height of 12 cm., and the largest of the Colorado specimens are of a similar height.

In 1910 Murrill (**2**) erected the new genus *Polyozellus* of the Agaricaceae based on Underwood's *Cantharellus multiplex* which at that time was known only from the type collection. In his key to the genera of Agaricaceae (*l. c.*) he separates his new genus from *Cantharellus* on the grounds that the hymenophores of the new genus are compound whereas those of the latter genus are simple. The compound hymenophore and the rugose hymenium are in part typical of the genus *Craterellus* and therefore the genus *Polyozellus* is considered to be superfluous. Since fresh material

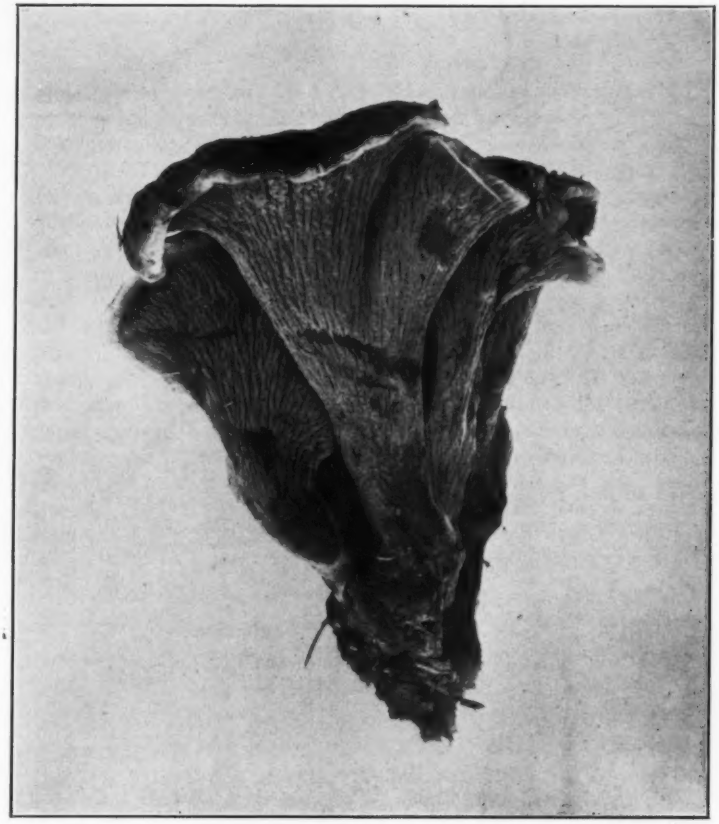

FIG. 1. *Craterellus multiplex* (Underw.) Shope, × 1. Photograph of fresh material collected in Colorado.

has been examined and photographed, and the type and Canadian collections have been examined, it seems advisable to place this species in the genus *Craterellus*. A redescription of the fungus seems also to be advisable and is as follows:

Craterellus multiplex (Underw.) comb. nov.

Cantharellus multiplex Underw. Bull. Torrey Club **26**: 254. 1899.

Polyozellus multiplex (Underw.) Murr. N. Am. Flora **9**: 171. 1910.

Fructifications cespitose-multiplex, 6–15 cm. high, occurring in compact masses up to 1 meter in diameter; pilei compound, at times confluent, flabelliform or rarely infundibuliform, attenuated into the stipe, 2–5 × 3–10 × 0.1–0.3 cm.; surface when fresh lead-colored, dark purple or blackish, drying blackish brown (2) (Ridg.[1]) to dusky neutral gray (Ridg.), indistinctly concentrically zoned with alternate zones of tomentum, the tomentum disappearing with age; margin tapered, rounded, undulate, lobed, white to whitish, rarely concolorous, hirsute, fertile below; context dark purple, 1–3 mm. thick, made up of thin walled gelatinized hyphae averaging 3 μ in diameter; hymenium rugose-wrinkled, cinereous, pruinose with the spores which easily rub off revealing the underlying purplish tissue; stipe indeterminate due to the decurrent wrinkled hymenium, 0.5–3 cm. long, 0.5–1 cm. in diameter, round, solid, branched or confluent, dark purple to black, occasionally covered with a whitish hirsutum, convergent with a common subterranean base; basidia 6 μ in diameter, 4-spored; spores copious, hyaline, irregularly globose to globose-ovate, 4–6 × 4–6 μ, tuberculate; cystidia none.

TYPE LOCALITY: Mt. Desert, Maine.

HABITAT: Ground under conifers and mixed woods.

DISTRIBUTION: Maine, Quebec, Can., and Colorado.

ILLUSTRATIONS: Bull. Torrey Club **26**: 254. 1899; photo × ¼. Mycologia **29**: 287. 1937; drawing × 1. This publication; photo × 1.

The writer is indebted to Drs. E. A. Burt and D. H. Linder for information communicated by correspondence, and to Dr. Fred J. Seaver for measurements of the unfragmented specimens in the type collection and for sending the author fragments of the type and Canadian collections for examination.

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[1] Ridgway, R. Color standards and color nomenclature. 1912.

REMARKS ON THE GENUS ROZELLA[1]

F. K. Sparrow, Jr.[2]

Several years ago, in connection with the description of a new species of *Rozella* parasitic on *Polyphagus* (**5**) and again (**6**) in describing a new marine species, I pointed out that a misconception had arisen in the literature with respect to this genus as originally established by Cornu (**1**). A further study of this question, particularly in the light of recent observations on a species parasitic on *Allomyces* (**4**), makes it imperative that a proper interpretation of the group be given before the situation becomes too confused.

As described by Cornu, *Rozella* included four species, all parasitic on other water fungi, which had in common 1. a sporangium wall fused so intimately with that of the host as to be indistinguishable from it, 2. zoöspores escaping by a circular opening which arises from the dissolution of a papilla, 3. a plasmodial thallus, 4. the formation of spherical resting spores with spiny walls and without companion cells. The species were described by Cornu in the following order: 1. *R. Monoblepharidis*, 2. *R. Rhipidii*, 3. *R. Apodyae*, 4. *R. septigena*. The first three caused marked hypertrophy (swelling) of the infected part of the host cell and each thallus formed a single sporangium. The last-named species, found on *Achlya* and later on *Saprolegnia* was distinguished from the others by the absence of any hypertrophy and by the fractional (successive) formation from the thallus of a linear series of sporangia which matured in basipetal succession and which were separated from each other by cross walls. The zoöspores of all these species were described as uniciliate, although in *R. septigena* spores with two or more cilia were formed under poor environmental conditions.

[1] Paper from the Department of Botany of the University of Michigan no. 644.

[2] Acknowledgment is made to the Faculty Research Fund of the University for aid given in the preparation of this paper.

Later, Fischer (**2**), in a study of a fungus on *Saprolegnia* considered by him to be *Rozella septigena*, showed the same sequence of development of sporangia and resting spores but, in contrast to Cornu's observations, found the zoöspores to be biciliate. Fischer did not stress this important difference but laid emphasis rather on the fact that his fungus was confined to *Saprolegnia* and would not infect *Achlya*. Overlooking the fact that Cornu listed and figured *Achlya* as the first host for his species (although it is posposible that only the sporangial stage was found on this fungus), Fischer erected a new species (*R. simulans*) for his *Achlya* parasite and retained the binomial *Rozella septigena* for the form on *Saprolegnia*. In this same paper he also pointed out what Cornu (l. c. p. 149) had clearly recognized, namely, that there were two distinct groups within *Rozella*, the "sporangium-group" containing Cornu's first three species, and the "septigena-group" containing *R. septigena* and *R. simulans*. Thus definite emphasis was given to Cornu's own idea of the dissimilarity of *R. septigena* from the other species. Finally, in Fischer's monograph (**3**) this separation was completed and Cornu's genus name *Rozella* was retained for the peculiar "septigena-group" while the "sporangium-group" was accommodated in a new genus, *Pleolpidium*.

Whether or not Cornu was mistaken, as Fischer infers, in the ciliation of the zoöspores of *R. septigena* is a point that unfortunately cannot be finally settled without a re-examination of the living material of Cornu's fungus—now unavailable. The strongly arched aguttulate zoöspores (Cornu l. c. pl. 6, fig. 2) are indeed similar to those found among members of the biciliate series (*Olpidiopsis, Petersenia*, etc.). It is also unquestionably true that in another case (*Olpidiopsis*) Cornu failed to detect the anterior cilium of the zoöspore. However, the principal feature stressed by Fischer was the formation of a linear sorus of sporangia, which character has been considered most important in distinguishing Cornu's *R. septigena*.

Whatever the characters of the original *Rozella septigena*, it is obvious that Fischer erred in applying the name *Rozella* to this aberrant species and in placing in a new group, *Pleolpidium*, the fungi clearly considered by Cornu to be typical of his genus of

which *R. Rhipidii* might best be considered the type (no zoöspores were seen in *R. Monoblepharidis*).

Further justification for the retention of *Rozella* in the sense of Cornu and not Fischer is to be found in the results of recent observations on a new species, *R. Allomycis*, parasitic on *Allomyces arbuscula* Butler (Foust, **4**). In this fungus sporangia are produced from the plasmodial thallus in basipetal succession and resting spores exactly like those of *R. septigena* are formed. As distinct from Fischer's *R. septigena*, however, the normal zoöspores produced from the sporangia and from germinated resting spores of *R. Allomycis* are unquestionably posteriorly uniciliate. If, then, a fungus with the characters of *R. Allomycis* exists on *Allomyces*, it is entirely probable that one possessing all the features of true *R. septigena* (sense of Cornu) will again be found on *Achlya* and *Saprolegnia*.

Clarification of this taxonomic situation can best be brought about by the retention of *Rozella* in its original sense by Cornu, necessitating the suppression of *Pleolpidium*, which becomes a synonym of *Rozella*. The genus would then consist of the following species, all possessing posteriorly uniciliate zoöspores: *R. Monoblepharidis* Cornu, *R. Rhipidii* Cornu (= *R. Araiosporae* Minden [3]), *R. Apodyae* Cornu, **R. irregularis** (Butler) comb. nov., **R. Cuculus** (Butler) comb. nov.,[4] **R. Blastocladiae** (Minden) comb. nov., *R. Polyphagi* Sparrow, *R. marina* Sparrow. The disposition of Cornu's *R. septigena* and *R. Allomycis* Foust is dependent upon how inconclusively the genus is to be interpreted. If it is restricted to those species in which a single sporangium results from an infection, then the last two species would be excluded and a new genus would have to be made for their accommodation. This group would differ from *Rozella* only in the formation of more than one sporangium from a single infection.

Fischer's fungi called *R. septigena*, a misdetermination, and *R. simulans*, both forms with biciliate zoöspores, vegetative body and resting spores like those of Cornu's *R. septigena*, should according to this arrangement also be placed in a new genus. Be-

[3] A change in the generic name of the host plant does not warrant a change in the species name of a parasite named for it.

[4] Probably includes *P. tuberculorum* Vuill. and *Chytridium simulans* Dang.

fore doing this, however, additional evidence confirming the biciliate character of the zoöspores in these fungi would be desirable.

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NOTES ON CLITOCYBE ILLUDENS [1]

W. F. HANNA [2]

(WITH 9 FIGURES)

I. THE OCCURRENCE OF DIPLOID OIDIA ON DIPLOID MYCELIUM

Since the announcement by Mlle. Bensaude (**1**) in 1918 of heterothallism in *Coprinus fimetarius*, a considerable number of species of Hymenomycetes have been studied in pure culture. In the course of such investigations it has usually been found that oidia are present in haploid cultures of heterothallic species, although in a few species they are apparently absent.

There is no record of the occurrence of oidia in cultures of homothallic species, and they are usually absent in diploid cultures of heterothallic species. The first instance of oidial production by a diploid culture of a heterothallic species was announced by Gilmore (**5**) in *Psilocybe coprophila*. She found that cultures of this species made from single oidia taken from the diploid mycelium usually produced haploid mycelia, although occasionally they produced diploid mycelia. In a recent paper Brodie (**2**) stated that he had failed to find oidia on the diploid mycelium of *P. coprophila*. However, in another species, *Collybia velutipes*, he showed conclusively (**3**) that the diploid mycelium produced haploid oidia.

Several species of Hymenomycetes are now known to produce diploid oidia on the diploid mycelium. This condition was observed by Martens and Vandendries (**7**, **8**, and **9**) in *Pholiota aurivella*, and later by Vandendries (**10** and **11**) in *Polyporus squamosus*, *Pleurotus pinsitus*, and *Trametes cinnabarina*. Kaufert (**6**) has also shown that the binucleate mycelium of *Pleurotus corticatus* may give rise to binucleate oidia. In addition to the diploid oidia, haploid oidia as well may develop on the diploid my-

[1] Contribution No. 527 from the Division of Botany, Experimental Farms Branch, Department of Agriculture, Ottawa, Canada.

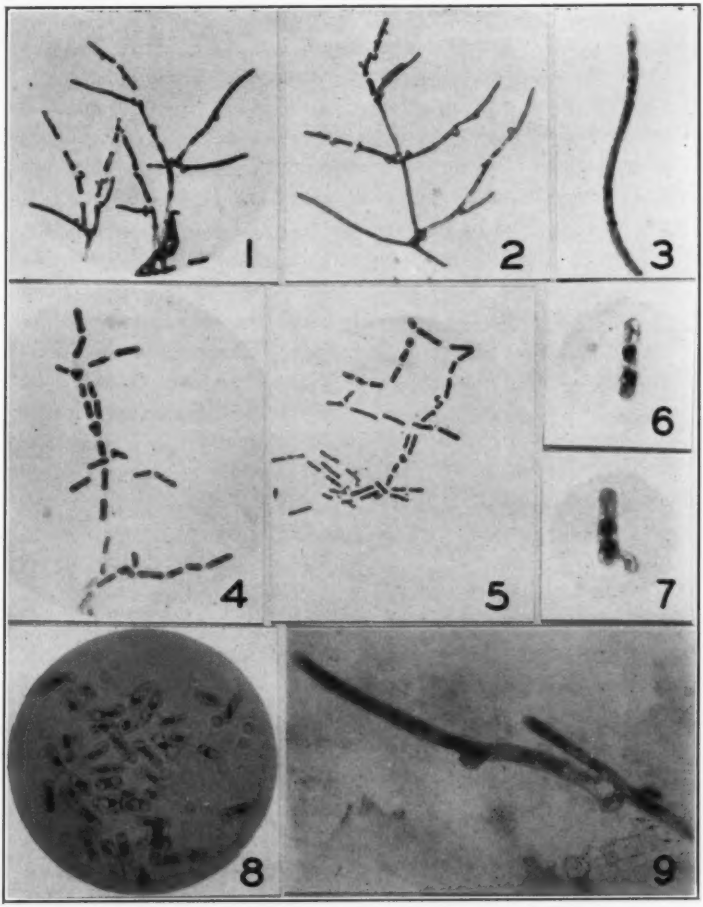
[2] Senior Plant Pathologist, Dominion Rust Research Laboratory, Winnipeg, Manitoba.

celium of *Pholiota aurivella* and *Pleurotus corticatus*. Apparently these are the only two species of Hymenomycetes in which both haploid and diploid oidia are known with certainty to occur on the diploid mycelium.

In the fall of 1931, while making observations on cultures of the luminous agaric, *Clitocybe illudens*, at the Osborn Botanical Laboratory, the writer [3] noticed an abundant development of oidia on cultures of the diploid mycelium of this species. The fruit-bodies from which the cultures originated had been collected by Prof. G. E. Nichols near New Haven. Polysporous cultures were made by suspending one of the fruit-bodies for a few moments above Petri dishes containing one or other of the following media: plain agar, malt agar, potato-dextrose agar, corn meal agar, prune agar, and bacto-dextrose agar. The plates were placed on a laboratory table and were examined from time to time during the next ten days, but no spores were observed to germinate. The plate containing malt agar was then placed for a few days in a refrigerator kept at about 3° C., after which it was returned again to the laboratory. About a week later the spores in this plate commenced to germinate and subsequently a dense growth of mycelium developed from them. Another culture was made from one of the fruit-bodies by plating out a piece of the stipe on malt agar. This culture, and the polysporous culture as well, gave rise to typical diploid mycelium bearing clamp connections.

Contrary to expectation both the polysporous culture and the stipe culture produced a profusion of oidia. The oidia were formed by the segmentation of aerial hyphae. Many of the hyphae that underwent segmentation had clamp connections and, where these were present, the break in the hypha occurred immediately in front of the clamp, leaving the remains of the clamp still attached to the oidium just behind the point of rupture. The appearance of the oidia and the manner in which they are formed are illustrated in figures 1, 2, 4 and 5. In these figures the hook-like remainders of clamps may be seen projecting from the ends of a number of the oidia. A single oidium of the same kind is shown under greater magnification in figure 7.

[3] Stirling Fellow in Yale University, 1931–1932, on leave of absence from the Dominion Rust Research Laboratory, Winnipeg, Manitoba.



FIGS. 1–9. *Clitocybe illudens:* 1–2, diploid hyphae, bearing clamp connections, segmenting to form oidia, × 340; 3, diploid hypha having pair of nuclei near the growing point, × 640; 4–5, chains of oidia, some with a portion of a clamp still attached, × 340; 6, diploid oidium, × 1500; 7, diploid oidium with portion of clamp projecting from lower end, × 1500; 8, group of diploid oidia, × 750; 9, diploid hypha showing disposition of nuclei during process of clamp formation, × 750. Preparations shown in figures 1, 2, 4, and 5 stained with lacto-phenol light green; remainder stained with haematoxylin and light green.

In all of the experimental investigations on sex in the Hymenomycetes it has invariably been found that clamp connections are borne only on diploid hyphae. The presence of clamp connections on the oidial-bearing mycelium of *C. illudens* may be regarded, therefore, as a reliable indication that the mycelium is diploid. Conclusive proof of this was obtained by examining fixed and stained preparations of the mycelium. Material suitable for this study was obtained by growing the mycelium on the surfaces of sterile glass slides that had been coated with a thin film of nutrient medium containing 2 per cent gelatin, 0.5 per cent agar, and 0.5 per cent malt extract. Slides on which the mycelium had been growing for about a week were fixed in Flemming's weaker solution and stained in Haidenhain's iron-alum haematoxylin and light green. Microscopic examination of these preparations showed that the nuclei in the mycelium usually occurred in pairs. The appearance of pairs of conjugate nuclei near the tips of young hyphae is illustrated in figures 3 and 9. The latter figure also shows the disposition of the nuclei during the process of clamp formation.

The nuclear condition of the oidia produced by the diploid mycelium was determined by observations made on mono-oidial cultures and stained preparations. Single oidia were taken from the culture made from stipe tissue, and were placed to germinate in separate hanging drops of potato-dextrose agar. Four of the five oidia isolated in this manner germinated and produced colonies, the hyphae of which bore clamp connections. The appearance of clamp connections in these cultures may be regarded as proof that a pair of conjugate nuclei were present in each of the four oidia.

Oidia taken from both the stipe culture and the polysporous culture were fixed in Flemming's weaker solution and stained in Haidenhain's iron-alum haematoxylin and light green. Microscopic examination of this material revealed the presence of two nuclei in the majority of the oidia, although in a few there were more than two and in some there was only one (FIGS. 6–8). No nuclei were visible in a certain number of the oidia, but the extent of this condition seemed to depend upon the degree of destaining. In the nuclei of many of the oidia definite structures resembling chromosomes were to be seen.

An attempt was made to determine the proportion in which uninucleate and binucleate oidia occurred. Three counts of 100 oidia each, made on one slide, gave the following result:

Count	1	12	uninucleate oidia:		88	binucleate oidia	
"	2	18	"	"	: 82	"	"
"	3	19	"	"	: 81	"	"

On the basis of these counts the ratio of uninucleate to binucleate oidia appears to be about 1 to 5. It is possible that in some of the oidia in which only one nucleus was visible there was actually present a second nucleus which had not retained the stain or was hidden from view by its sister nucleus. There remains, however, the possibility that a few of the oidia were haploid, having received only a single nucleus during the process of oidial formation.

II. BIOLUMINESCENCE

Buller (**4**), in his discussion of bioluminescence in fungi, reviewed the observations which had been made on the luminescence of *C. illudens*. According to him it appears to have been well established that the fruit-bodies of this species are luminous; but some doubt seems to exist as to the luminosity of the mycelium. The following comment on this question is offered by Buller: "W. A. Murrill ("Luminescence in the Fungi," Mycologia **7**: 132. 1915) observed that the wood on which some fruit-bodies of *C. illudens* grew was luminous in the dark and therefore concluded (p. 115) that the mycelium of *C. illudens* is luminous. There is, however, the bare possibility that the mycelium in the wood may have belonged to some other fungus, *e.g. Armillaria mellea*. It is therefore desirable that some one should establish the luminosity of the mycelium of *C. illudens* on the basis of pure cultures."

Observations made by the writer have failed to confirm Murrill's conclusion that the mycelium of *C. illudens* is luminous. The fruit-bodies of this species collected by Prof. Nichols near New Haven, when examined in a photographic dark-room, were found to be distinctly luminous, but pure cultures of the mycelium, whether originating from pieces of stipe or from spores, failed to show a trace of luminosity. As a check on the conditions under which the examinations were made, a pure culture of *Panus stypti-*

cus luminescens was included along with the cultures of *Clitocybe illudens*. That the conditions were satisfactory was proven by the fact that no difficulty was experienced in detecting the light given out by the culture of *Panus stypticus luminescens*. From these observations, therefore, it may be concluded that the fruit-bodies of *Clitocybe illudens* are luminous, but that pure cultures of the mycelium are non-luminous.

SUMMARY

1. The production of oidia from diploid mycelium, a phenomenon of relatively rare occurrence in species of Hymenomycetes, has been observed in *Clitocybe illudens*. The oidia produced on the diploid mycelium of this species are diploid and, on germination, give rise to mycelia bearing clamp connections.

2. The fruit-bodies of *C. illudens* are luminous, but luminescence could not be detected in pure cultures made from a piece of the stipe and from spores of a luminous fruit-body.

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SOME NEW GRASS SMUT RECORDS FROM THE PACIFIC NORTHWEST [1]

GEORGE W. FISCHER [2]

(WITH 3 FIGURES)

As part of the investigations of the smut diseases of forage grasses, recently begun in the Pacific Northwest, the writer has intensively collected grass smuts in this region, and has had many specimens sent to him. There has resulted a gradual accumulation of new records, establishing some grasses as new hosts to certain smut fungi, or of some smuts as new or imperfectly understood species.

Most of the records are from the State of Washington, from which state Zundel (**7**, **8**) has already issued two lists of the smut fungi.

The reports of new hosts and new species of smut fungi contained herein are supported by herbarium specimens deposited in the Herbarium of the Plant Pathology Department of the State College of Washington, Pullman, Wash., and the Mycological Collections of the Bureau of Plant Industry, Washington, D. C.

USTILAGO HYPODYTES (Schlecht.) Fries

Ustilago hypodytes has been reported on a diverse range of grasses. Liro (**5**) lists some 26 genera and 58 species of grasses as hosts, while Bornhövd (**2**) lists 71 species. Even these are not complete as some American grass hosts are not included.

During the past two seasons the writer has collected *U. hypodytes* on three forage grass species that have not, apparently, been previously recorded as hosts to this smut. These new hosts follow:

[1] Grass disease investigations of the Division of Forage Crops and Diseases, Bureau of Plant Industry, U. S. Department of Agriculture, in cooperation with the Soil Conservation Service, Section of Nurseries, and the Divisions of Plant Pathology and Agronomy of the Agricultural Experiment Station, State College of Washington.

[2] Associate Pathologist, Division of Forage Crops & Diseases, Bureau of Plant Industry, U. S. Department of Agriculture.

On *Agropyron pauciflorum* (Schwein.) Hitchc. In field of *A. pauciflorum* on College Farm, Pullman, Wash. Coll. G. W. Fischer, F–E, July, 1936 and 1937.

Agropyron inerme (Scribn. and Smith) Rydb. In open field associated with heavily infected *A. repens,* Pullman, Wash. Coll. G. W. Fischer, F–F, June 20, 1937.

Agropyron cristatum (L.) Beauv. Soil and Water Conservation Experiment Station, Pullman, Wash. In field of *A. cristatum* June, 1937. Coll. V. B. Hawk; College Farm, Pullman, Wash. In two fields of *A. cristatum* June 21, 1937. Coll. G. W. Fischer, F–D; Max Hinrichs Farm, in large field of *A. cristatum,* July, 1937. Coll. G. W. Fischer.

The appearance of stem smut, *U. hypodytes,* in some of our best forage grasses may be occasion for alarm, since this smut very materially lowers the quality of the affected grass for hay, or may render it entirely unfit. The fact that the mycelium is perennial in the host for an indefinite period adds to the importance of the disease. Furthermore, the seed production of affected plants is reduced to almost nothing, since smutted culms rarely bear an inflorescence. The disease on crested wheat grass seems to be somewhat of an exception to this, for on this host it is not at all uncommon to find a fairly well developed spike on a smutted culm (FIG. 1, *B*).

Ustilago hypodytes is very common in some areas of the Northwest, especially on *Oryzopsis hymenoides* (Roem. and Schult.) Ricker, *Stipa comata* Trin. and Rupr., and *Agropyron repens* (L.) Beauv.

USTILAGO BULLATA Berk.

In a recent paper (3) the writer listed the recognized hosts of *U. bullata.* Collections and inoculations during 1937 have added 6 grass species as new hosts to this smut:

On *Agropyron caninum* (L.) Beauv. Resulting from inoculation from *Hordeum nodosum,* in writer's grass smut nursery. Pullman, Wash. Aug., 1937.

Agropyron inerme (Scribn. and Smith) Rybd. Soil Conservation Nurseries, Pullman, Wash. Coll. G. W. Fischer, N–E, July, 1937.

Elymus canadensis L. Soil Conservation Nurseries Increase plots, Pullman, Wash. Coll. Carl Riesenweber, N–H and N–J, Aug. 21, 1937.

Elymus glaucus Buckl. Resulting from inoculation from *Agropyron pauciflorum* in writer's grass smut nursery, Pullman, Wash Aug., 1937.

Elymus glaucus Jepsoni Davy. Soil Conservation Nurseries Increase Plots, Pullman, Wash. Coll. G. W. Fischer, N–G, Aug. 20, 1937.

Elymus sibiricus L. Soil Conservation Nurseries Increase Plots, Pullman, Wash. Coll. G. W. Fischer, N–F and N–I, Aug. 21, 1937.

USTILAGO HORDEI (Pers.) Kellerm. & Swingle

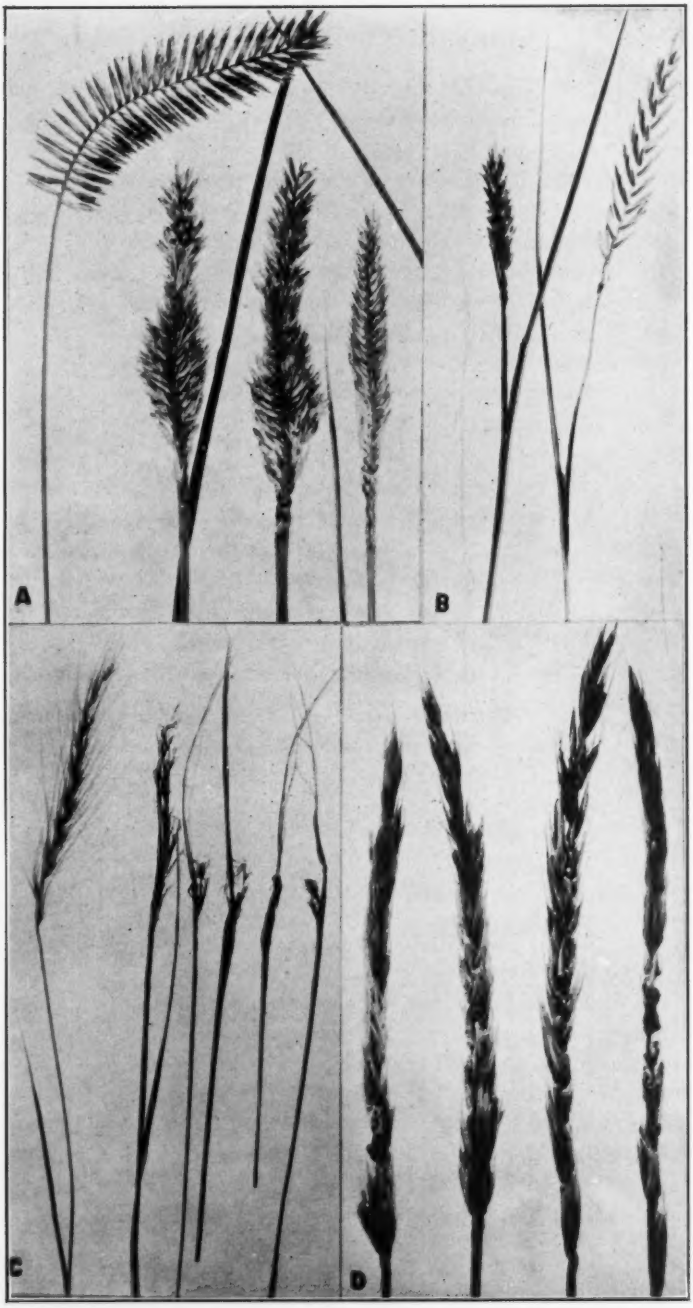
Thus far, apparently, the organism causing the covered smut of barley, *Ustilago Hordei,* has been limited to the cultivated species of the genus *Hordeum.* During 1937, however, the writer made one collection, and has had two others sent to him, of a smut on *Agropyron* and *Elymus,* which are morphologically indistinguishable from *U. Hordei.* These collections are as follows:

On *Agropyron cristatum* (Fairway variety, seed from Creston, Montana) Pullman, Wash. Soil Conservation Nurseries. Coll. Carl Riesenweber, E–C, July 15, 1937.

Elymus glaucus Jepsoni, Pullman, Wash. Soil Conservation Nurseries Increase Plots. Coll. G. W. Fischer, E–A. July 29, 1937.

Agropyron cristatum, Bozeman, Mont. Coll. L. P. Reitz, E–B. Aug., 1937.

With the exception of the second collection, on *Elymus,* the smut presents the appearance of one on an unfavorable host. On *Agropyron cristatum,* especially the collection from Bozeman, Mont., the sori are small and rather poorly developed. The specimens of this smut on the same grass from Pullman are scarcely better, and the sori are mostly toward the base of the spike, involving the lowermost spikelets. The infected culms are shorter, and noticeably thickened toward the region of spore production as shown in figure 1, *A.* The smut seems to find a more com-


A
B
C
D

patible host in *Elymus glaucus Jepsoni,* for the sori are better developed, and spore production more abundant (FIG. 1, *D*).

As is seen in figure 2, *A, C, E, G,* the spores of the three collections are indistinguishable, either from each other, or from *U. Hordei.* Furthermore, there are no significant differences in the germinating spores of the three grass smut collections in comparison with *U. Hordei* and *U. levis* (FIG. 2, *B, D, F, H, I*).

Considering the striking identity, from the standpoint of comparative morphology of the spores and germinating spores, of the three grass smut collections with either *U. Hordei* or *U. levis,* it is evident that the smut on the grasses does not justify the erection of a new species. Since *U. Hordei* and *U. levis* are morphologically the same species, these grass smut collections could be assigned equally well to either. However, since some choice is necessary, the grass smut is temporarily assigned to *U. Hordei.*

It will be interesting to see how much of this assumed relationship, based on comparative morphology, can be substantiated by cross-inoculation experiments. The writer has all three of the grass smuts, as well as *U. Hordei* and *U. levis* in culture. These cultures will be used for cross-inoculation experiments with various grasses, and susceptible barley and oat varieties.[3]

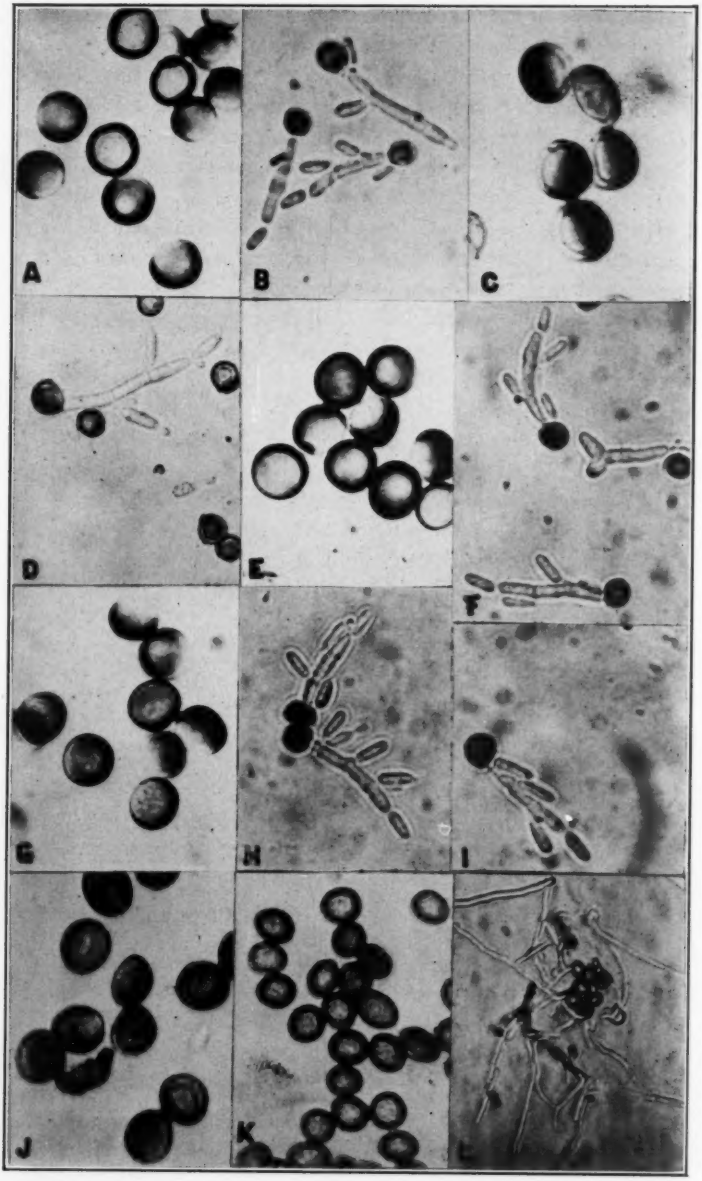
USTILAGO TRITICI (Pers.) Rostr.

On *Agropyron sibiricum* (Willd.) P. B. In Soil Conservation Nurseries, Pullman, Wash. Coll. G. W. Fischer, V–A, July 28, 1937.

On the basis of spore morphology and spore germination the collection V–A indicated above is indistinguishable from *Ustilago Tritici.* The spores (FIG. 2, *J* are brown, lighter-colored on one side, subglobose to globose, minutely echinulate, and are 5–7.5 μ

[3] At the time of the return of galley proof of this paper sufficient barley has matured in the greenhouse to indicate the susceptibility of Trebi and Beldi varieties to each of these three grass collections of *Ustilago Hordei.*

FIG. 1. *A,* normal culm and spike of *Agropyron cristatum,* and three affected with what is apparently *Ustilago Hordei* (collection *E–C* in text); *B, U. hypodytes* on *Agropyron cristatum,* showing spikes on smutted culms; *C, Ustilago Sitanii* on *Sitanion jubatum,* one normal and five typical smutted heads; *D, Ustilago Hordei* on *Elymus glaucus Jepsoni* (collection *E–A* in text). *A–D* somewhat reduced.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L

in diameter. On germination the spores give rise directly to a mycelium, without the production of sporidia, even on rich nutrient media.

Since *Ustilago Tritici* and *U. nuda* (Jens.) K. & S. are morphologically the same species the above collection might perhaps have been referred to the barley smut, but is assigned, at least temporarily, to *U. Tritici*.

The general appearance of this smut on *A. sibiricum* gives the impression of being on a somewhat incompatible host. While the spikes are more or less blighted, there is not the lavish spore production nor the complete destruction of the floral parts characteristic of *U. Tritici* on susceptible wheats.

Ustilago Sitanii sp. nov.

Sori principally in the distorted inflorescence, more or less destroying it, involving chiefly the awns, glumes, and other floral parts, but also to some extent forming long and short striae on the upper leaves and leaf sheaths, early naked and dusty, revealing the dark-brown spore mass; spores light-brown, globose to ellipsoidal, uniformly rather thick-walled, 3.5–5 × 3.5–7 μ, mostly 4 × 5 μ, minutely echinulate.

On *Sitanion jubatum* J. G. S. Warwick, Klickitat Co., Wash., June, 1936. Coll. Roderick Sprague and B. B. Bayles. G. W. Fischer, U–A, June 15, 1937.

Sitanion Hanseni (Scribn.) J. G. S. Klickitat Co., Wash. June 15, 1937. Coll. G. W. Fischer, U–B. Klamath Falls, Ore. Coll. D. C. Smith. Aug. 8, 1937.

Soris atro-brunneis, in inflorescentia, foliis, et vaginis foliorum, primo liberis et pulverulentis; sporis dilute brunneis, globosis vel ellipsoidesis, 3.5–5 × 3.5–7 μ, plerumque 4 × 5 μ, minute echinulatis.

FIG. 2. *A*, spores of *Ustilago Hordei* from *Elymus glaucus Jepsoni* (collection *E–A*); *B*, *Ibid.*, germinating on prune-dextrose agar; *C*, spores of *U. Hordei* from *Agropyron cristatum* from Bozeman (collection *E–B*); *D*, *Ibid.*, germinating on prune-dextrose agar; *E*, spores of *U. Hordei* from *Agropyron cristatum* from Pullman (collection *E–C*); *F*, *Ibid.*, germinating on prune-dextrose agar; *G*, spores of *U. Hordei* from cultivated barley, Beldi variety; *H*, *Ibid.*, germinating spores; *I*, germinating spore of *U. levis* from cultivated oats, included for comparison with *B*, *D*, *F*, *H*; *J*, spores of *U. Tritici* from *Agropyron sibiricum*; *K*, spores of *U. Sitanii*; *L*, *Ibid.*, germinating on prune-dextrose agar. All spores × about 1200; all germinating spores × about 500.

Hab. in inflorescentia et vaginis foliorum *Sitanion jubatum* J. G. S. et *S. Hanseni* (Scribn.) J. G. S., Washington, Oregon, in Amer. bor. Coll. R. Sprague, B. B. Bayles, G. W. Fischer, D. C. Smith. Jun., Aug., 1936, 1937.

Superficially this smut compares favorably with *Ustilago longissima* (Sow.) Tul. However, even though the spores of the two species are indistinguishable (except that the spores of *U. longissima* are very slightly larger) the two are separable as follows: (1) *U. longissima* is principally a leaf smut, whereas *U. Sitanii* occurs chiefly in the spikes; (2) *U. longissima* spores germinate indirectly, producing, according to Bauch (**1**), numerous sporidia. Thus far, on a variety of nutrient media, the spores of *U. Sitanii* have been observed to germinate only directly (FIG. 2, L) in a manner very similar to *U. nuda* (Jens.) K. & S. *Ustilago Sitanii* differs from *U. nuda,* however, in the smaller spores of the former, and in the fact that the spores are uniformly thickened, not thin-walled on one side, as in *U. nuda.*

The typical appearance of heads of *Sitanion* affected with this smut is shown in figure 1, C, and the spores in figure 2, K.

USTILAGO STRIAEFORMIS (Westend.) Niessel.

A survey of the literature reveals that *U. striaeformis* has been reported on a large number of grasses, over 30 species being listed by Liro (**5**) alone. To this number can be added, however, the following apparently heretofore unreported host species:

On *Agropyron pauciflorum.* In Soil Conservation Nurseries, Pullman, Wash. Coll. G. W. Fischer, L–A, Aug., 1936. This material was used for inoculation experiments which established the following grasses as new hosts:

Agropyron caninum
Agropyron cristatum
Agropyron inerme. (Also collected by D. C. Smith and G. W. Fischer, Dayton, Wash. May, 1936; and by Rexford Daubenmire, Colfax, Wash., June, 1937.)
Agropyron spicatum

TILLETIA GUYOTIANA Har.

Tilletia Guyotiana was first reported from North America by Zundel (**7**) in 1920. Heretofore, this smut has been known only on *Bromus mollis* L. (*B. hordeaceus* L. of earlier authors) in this country, and on *B. hordeaceus* in Europe. In 1935 and 1936, however, the writer found *B. brizaeformis* Fisch. and Mey. rather heavily infected:

On *Bromus brizaeformis*. Kamiaken Butte, Palouse, Wash. Coll. G. W. Fischer, O–B, Aug., 1935 and June, 1936. In association with heavily infected *B. mollis*.

Tilletia pallida sp. nov.

Sori in the ovaries, .5–1 mm. in length; sterile cells few, smaller than the spores, hyaline, thin-walled, smooth; spore mass light-brown or buff; spores pale yellowish-brown to hyaline, globose, with 3 μ deep, hyaline, irregular reticulations, often appearing cerebriform or even coarsely verrucose, 16–24 μ, mostly 19–20 μ in diameter.

On *Agrostis palustris* Huds. Coll. R. Sprague, unnumbered collections 1929–35; G. W. Fischer, in field of seaside bent grass on Tway Farm, Coquille, Oregon, Aug. 11, 1937. Also in numerous seed samples received at the Oregon Experiment Station.

Soris in ovariis, .5–1 mm. longis; cellis sterilibus paucis, hyalinis, glabris, sporis dilute flavo-brunneis vel hyalinis, globosis, reticulatis; lineolis 3 μ altis; aerolas reticuli irregularibus, cerebriformibus vel verruculosis, 16–24 μ, plerumque 19–20 μ diam.

Hab. in ovariis *Agrostidis palustris* Huds. Coos County, Oregon, in Amer. bor.; coll. R. Sprague, G. Fischer, et al. Aug. 1929–37.

This smut was reported by Sprague (**6**) in 1935 as *Tilletia decipiens* (Pers.) Körnicke, in the belief that it was identical with the *Agrostis* smut in Germany. The following description of *T. decipiens* was taken from Lindau (**4**):

Sporenhaufen schwarz, fest, die Fruchtknoten zu kleinen, festen Körnern umwandelnd, die beim Zerreiben übel riechen. Sporen kugelig, 24–28, meist 26 μ im Durchmesser, mit dunkelbraunem Epispor, dessen netzleisten 2.5–3 μ hoch und dessen Maschen 4 μ weit sind.

Descriptions in Saccardo (**7**: 482) and Thome's Flora von Deutschland (Migula, W. Kryptogamen-Flora **3**[1]: 264) are al-

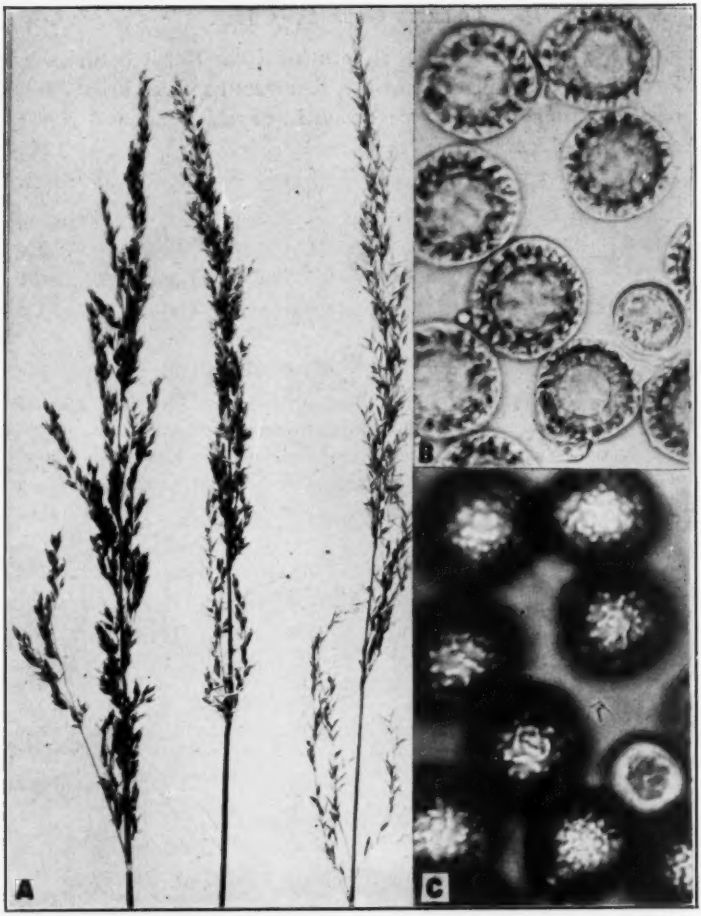

FIG. 3. *A–C, Tilletia pallida. A,* two smut-infested and one normal inflorescence, approx. nat. size; *B,* spores, median view, × about 900; *C,* same group of spores as in *B,* but in surface view.

most identical with the above of Lindau's. From these it is obvious that the smut on *Agrostis palustris* in this country lacks the black spore mass, the dark-brown spores, and the wide, regular reticulations of *T. decipiens,* in addition to having spores several microns smaller in diameter (FIG. 3, *B* and *C*).

Smutted panicles are rather inconspicuous, especially when only a floret here and there contains a smut ball as is often the case. Completely smutted panicles, however, are more easily detected due to the plump or expanded appearance of the florets (FIG. 3, *A*). The smut balls are commonly found in seed samples from the Oregon Coast, especially from Coos County. This smut on seaside bent grass is alarming the growers of this grass in Southwestern Oregon, principally in Coos County, where the disease appears to be most firmly established and has been known for several years. It seems to be increasing yearly.

Attempts to germinate the spores have not been especially successful. Some germination has been observed and it may be said that the process is typical of a *Tilletia*.

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REVISION OF THE GENUS ANCYLISTES

HELEN BERDAN

(WITH 22 FIGURES)

The genus *Ancylistes* is at present separated from the other members of the order Ancylistales by its characteristic method of infecting by tubes instead of by zoöspores. The purpose of this paper is to present evidence of a more fundamental basis for this separation in the fact that *Ancylistes* reproduces asexually by conidia forcibly discharged from conidiophores as in the Entomophthorales. Since this has been established in two species, which are here reported for the first time in North America, it seems desirable to present a preliminary report of a detailed paper pending publication.

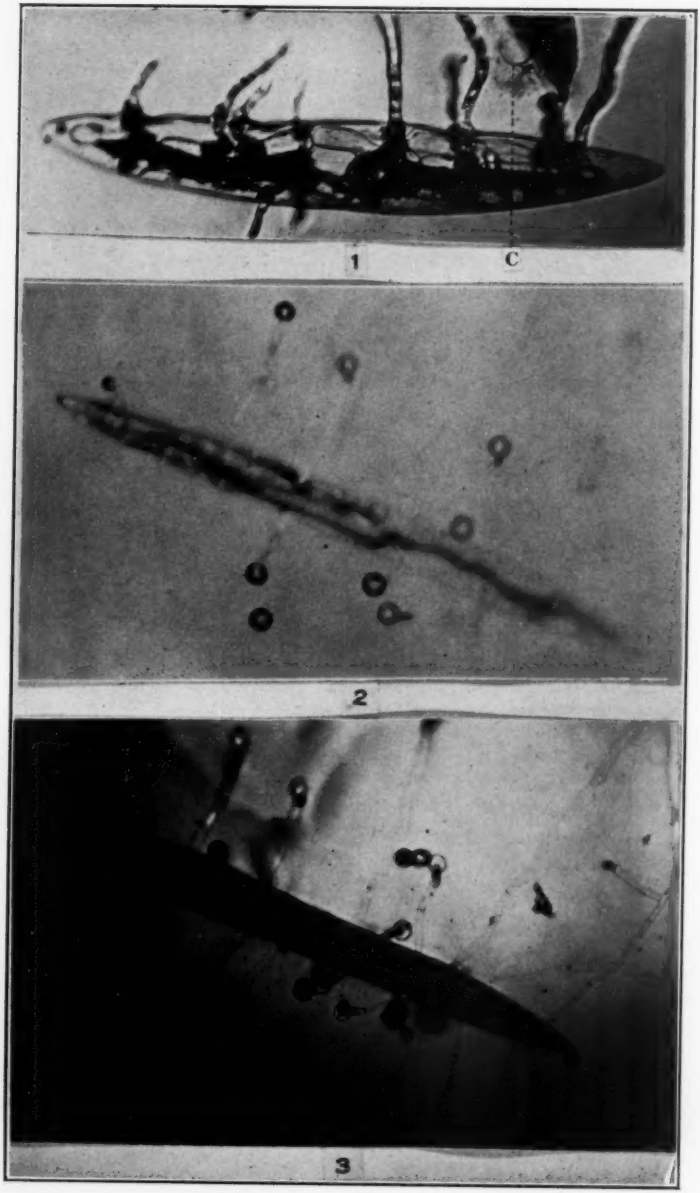
Ancylistes is reported in the literature as including four species, one of which is very doubtful and possibly altogether invalid. It was established in 1872 by Pfitzer (**19**) for a single species, *A. Closterii,* which he found parasitizing *Closterium acerosum* at Bonn, Germany. This species has subsequently been reported and described by Dangeard (**8**, **9**, **10**, **11**), Sorokine (**20**, **21**) Wildeman (**27**, **28**, **29**), Constantineanu (**6**), Petersen (**17**, **18**), Schultz-Danzig (**23**) and Valkanov (**25**) from France, Central Asia, Belgium, Roumania, Denmark, Germany, and Bulgaria, respectively. In 1895 Fritsch (**12**) proposed another species, *A. cladocerarum,* parasitic in rotifers, but in 1897, when Schröter (**22**) established the order Ancylistales with *Ancylistes* as the type genus, he failed to recognize Fritsch's species. In the same year a third species, *A. Pfeifferi,* found by Löfgren in Pirassununga, Brazil, was added to the genus by Beck (**2**, **3**); finally a fourth species, *A. Miurii,* was described by Skvortzow (**24**) in *Closterium* sp. from North Manchuria in 1925.

While collecting algae and particularly desmids around London, Canada, the writer became interested in the parasitic Ancylistales. Species of *Lagenidium* and *Myzocytium* were collected

and tentatively identified and in addition, in dead specimens of *Closterium* sp., another unidentified form was found with irregularly warted brown spores. This latter appears now to be closely related if not identical with the species which I am describing from Chapel Hill, North Carolina, as *Ancylistes Pfeifferi.*

For further study of this order of fungi and for learning methods of artificial culture, I went to the University of North Carolina in June 1937. Unpublished notes and drawings of Professor John N. Couch shown me there disclosed the finding of several species of *Myzocytium* and *Lagenidium* and *Ancylistes Closterii* around Chapel Hill by Prof. Couch and students of Dr. W. C. Coker. Because of the remarkable characters of *Ancylistes,* it was decided, at the suggestion of Professor Couch, to make collections of *Closterium,* and on June 24 the fungus was again found in what appears to be *C. striolatum* from the muddy bottom of a stagnant pool in Sparrow's cow pasture. This species has been tentatively designated *A. Closterii,* since the walls of the cell enclosing the zygote are smooth as in Pfitzer's species. The supply of *C. striolatum* gradually diminished in the pool, and by the end of July *C. areolatum* was predominant, especially in the deeper parts. On July 29 this alga was also found to be infected by another species of *Ancylistes,* which was later identified as *A. Pfeifferi* when the typical, warted, resting spores appeared on August 3. Neither of these species, but particularly *A. Pfeifferi* which has never been illustrated nor even adequately described, conforms exactly to the original report.

On June 26 an infected specimen taken from the surface of the water and examined under a cover glass showed three large, spherical bodies borne at the end of separate external hyphae. The appearance and structure of these bodies were strikingly similar to those of the conidia of *Conidiobolus* (**7**), as seen in living material and the suggestion became at once obvious that they related to an hitherto unknown type of asexual reproduction in *Ancyclistes.* Consequently, a second mount was made from specimens floating on the surface of the water and examined without a cover slip. Numerous similar bodies in the process of formation, as well as others being forcibly discharged were observed. Thus it became apparent that under these conditions the so-called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infection tubes function as conidiophores and produce conidia. The conidia appear as dark, glistening spheres at the end of the external hyphae or conidiophores as they emerge from the water into the air. The length of the conidiophore varies with the position of the desmid relative to the surface of the water and the direction which the external hypha takes after emerging from the *Closterium* cell (FIG. 2). In its swollen tip and subtending the conidium is a refractive, blue-green-appearing vacuole, around or through which the protoplasm streams upward in the formation of the conidium (FIG. 2, 3). The latter is discharged into the air and usually drops back into the water where it may germinate directly into a secondary conidium (FIG. 5) or by a germ tube (FIG. 1c). So long as the germ tube remains completely immersed in the water it functions as an ordinary external hypha, continuing to grow until its protoplasm is presumably exhausted. If the germ tube makes proper contact with a new host cell direct infection will occur from a swollen end cell, but should it extend into the air, another conidium is formed as in *Conidiobolus villosus* Martin (**16**). Such secondary conidia may be discharged normally or germinate while still attached by the formation of a germ tube. Mature primary conidia which are not discharged may germinate *in situ* to form secondary and occasionally tertiary conidia (FIG. 3), which may either be discharged or germinate by a tube while still attached to the conidiophore.

It was later found that conidia could be produced at will by passing a gentle current of air over the surface of a drop of water containing infected *Closterium* cells, and taking care to prevent excessive evaporation.

This discovery of forcibly discharged conidia necessitates the removal of *Ancylistes* from the Ancylistales to the Entomophthorales and a revision of the genus as it now stands.

FIGS. 1–3. *Ancylistes Closterii:* 1, young *Closterium* in water with external and internal hyphae (note conidium *c* with germ tube), × about 210; 2, old hypertrophied *Closterium* with external hyphae producing conidia in air (note "vacuoles" below conidia and varying lengths of conidiophores), × about 140; 3, same as 2, about 15 minutes later (note secondary and tertiary conidia, empty conidial cases from which secondary conidia have been discharged, branching and septations in external hyphae, conidium forming on branch), × about 140.

ANCYLISTES Pfitzer, Monatsb. Akad. Berlin 379. 1872.

Intramatrical mycelium consisting of one to several septate, tubular hyphae, variable in diameter, straight or slightly wavy, irregularly branching and anastomosing in the isthmus of the host or sparingly in other places by short lateral branches; segments of hyphae somewhat swollen, more or less constricted at the cross septa; cytoplasm with numerous rounded, highly refractive granules and somewhat regularly arranged, conspicuous vacuoles; cell walls giving no cellulose reaction with chlor-iodide of zinc. Each external hypha formed as a lateral outgrowth from an intramatrical segment; passing through the wall of host as a narrow papilla and emerging as a tubular, occasionally branched hypha into which the content of the internal segment flows and is later cut off posteriorly by a septum; growth of external hypha by progressive flow of protoplasm into advancing tip and the successive formation of cross walls. Asexual reproduction by conidia produced at the tips of the external hyphae or conidiophores and forcibly discharged into the air; conidia spherical, hyaline; columella conical, subtended by a vacuole and extending into the mature conidium before it is discharged, collapsing afterwards; conidia forming secondary or tertiary conidia directly or germinating by tube; germ tubes functioning as infection tubes or as conidiophores. Formation of conidia suppressed under water, external hyphae functioning as infection tubes. Sexual reproduction by lateral or scalariform conjugation of the contents of unequal gametangia; zygote formed in a protuberance of the female gametangium and retracted from its wall; wall of this protuberance smooth or with 9–10 truncate warts; zygote oval, spherical, thick-walled with numerous refractive globules; germination unknown.

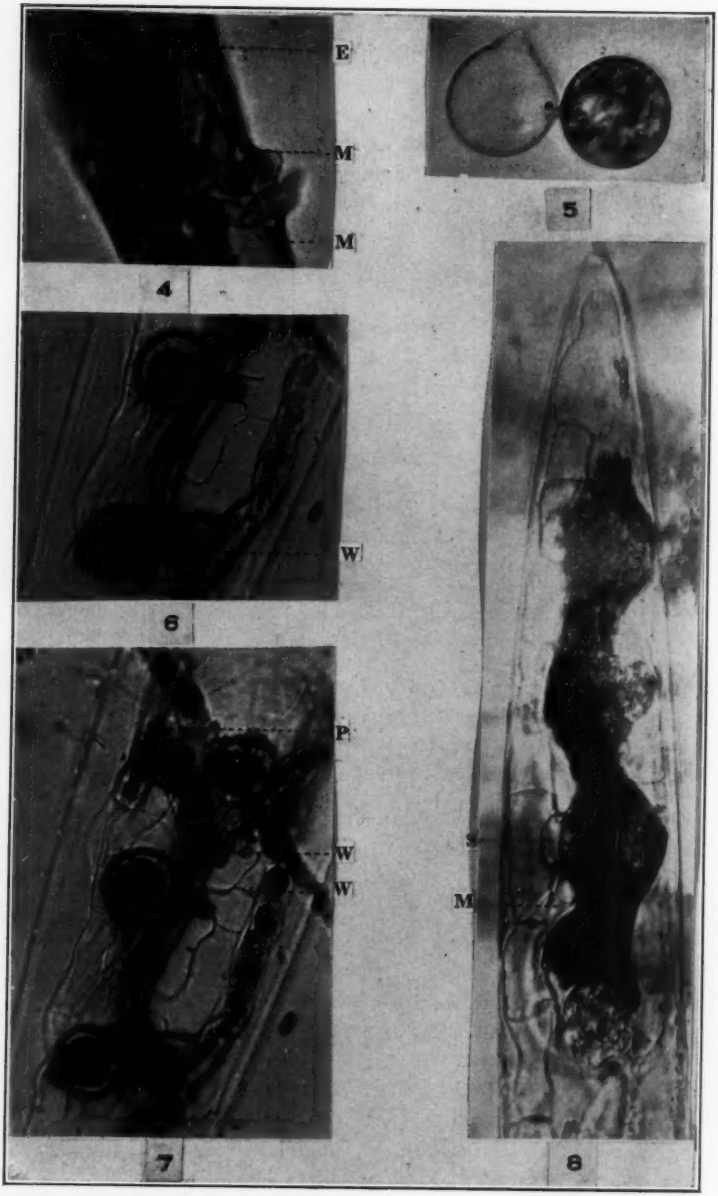
In all of the species which have so far been intensively studied infection occurs from the swollen end cell of a germ tube or infection tube in contact with the wall of the host cell (FIG. 9). Penetration is effected by a fine conical papilla, similar to that in figure 13, developed at the end of the infection cell, which elongates inside the host into a narrow cylindrical tube. The protoplasm of the swollen external infection cell then flows rapidly through this tube into the desmid cell and forms an ovoid, ball-like structure within (FIG. 15, 16), as was early described and figured by Pfitzer. This structure depresses the plates of the chromatophore (FIG. 16), and then commonly elongates in the cytoplasm between them to form continuous internal hyphae, which

later become septate and either give rise to external hyphae or are transformed directly into gametangia. The external hyphae in a position to project into the air function as conidiophores, while those submerged in water continue to grow until their protoplasm is exhausted or they encounter a new host cell. In the latter case they function as infection tubes, and in making contact they arch over at right angles to the host wall (FIG. 9) or hook and coil around the *Closterium* cell as has been described and figured by Pfitzer. Once in contact, the entire content of the infection tube flows by progressive stages into the attached tip and thus forms the swollen terminal infection cell.

ANCYLISTES CLOSTERII Pfitzer, l.c. *figs. 1–16.*

Intramatrical mycelium irregularly, 7.5–11 μ, wide before septation; cells or segments swollen, more or less constricted at septa, 11–15 $\mu \times$ 12.5–55 μ, mostly 25–35 μ long, usually with one median and two terminal vacuoles outlined by large, conspicuous, rounded, highly refractive granules, the latter also forming occasional isolated groups in the hyaline cytoplasm. External hyphae one per internal segment, frequently forming at adjacent sides of a cross wall, tubular, occasionally branched, 3–7.5 μ in diameter. Conidia hyaline, spherical, 13.5–17.5 μ, usually 15 μ, in water with a 5 μ long, basal papilla; germinating by a tube, 5 μ in diameter, or forming secondary and tertiary conidia directly. End of conidiophore swollen, 6–7.4 μ, at the base of the conidium and projecting into the undischarged conidium as a conical columella with a minute apical aperture; swollen end cell of germ and infection tube 8–10 $\mu \times$ 30–60 μ; appressorium barely discernible or lacking. Conjugation lateral or scalariform, gametangia developed simultaneously as lateral outgrowths from cells of the intramatrical hyphae and delimited by 1 or 2 septa depending upon their terminal or median position; male gametangium narrow, 3.5–7.5 μ, straight or slightly curved, female gametangium rounded and enlarged; fusion occurring near base of female gametangium. Zygote developed in smooth-walled protuberance of the female gametangium, separated from the main filament by a short stalk cell; zygote or resting spore smooth, brown, thick-walled, spherical, 14.5–20 μ, usually 18.5 μ, filled with refractive globules, retracted slightly from the enclosing cell, the latter forming an even, hyaline envelope; germination unknown.

Parasitic in species of *Closterium* in Germany, Central Asia,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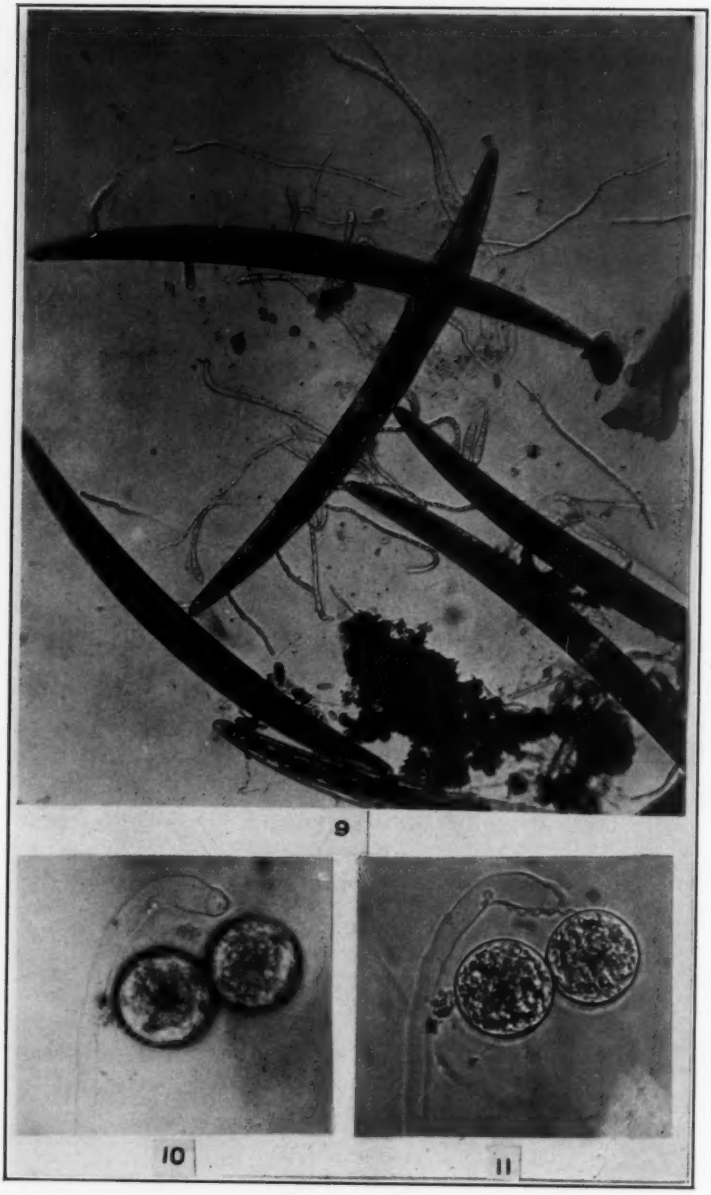
Belgium, Roumania, Denmark, Bulgaria, Mississippi, and North Carolina, U. S. A.

Dangeard (**8**) reports that the resting spores or zygotes of this species germinate by a tube, but in light of the above observation it is probable that his figures relate to germinating conidia. The spores which he figures are hyaline and thin-walled with a homogeneous content and resemble the conidia which I have found. It is to be noted in this connection that Sorokine (**20, 21**) also found hyaline, spherical, conidia-like bodies in his study of this species, but he mistook them for quiescent zoöspores.

The formation of external hyphae or so-called infection tubes may be very profuse in this species. As many as sixty-five have been seen radiating from a single infected *Closterium* cell. Some of these extended for a distance of 1.2 mm. without showing any signs of deterioration, although no new host cells had been encountered. The chromatophore in contact with the infection cell shrinks away rapidly and markedly from the *Closterium* wall, and very violent waves of cytoplasmic streaming are set up in that region.

My observations to date on this species do not agree entirely with Pfitzer's original description nor with the subsequent ones of Dangeard, and there is accordingly a possibility that they do not relate to *A. Closterii,* although our measurements correspond. Pfitzer's species is described in the literature as being heterothallic with an appreciable difference in diameter of the male and female filaments, while my fungus, from the data at hand, appears to be homothallic. Furthermore, the exit hyphae of my species are quite distinctive. They develop as lateral outgrowths, 3–5.5 μ in width,

FIGS. 4–8. *Ancylistes Closterii:* 4, formation of external hyphae from 3 vegetative cells (note flat end *e* pressed against membrane, position of cytoplasmic membrane *m* and paired effect of hyphae), × about 480; 5, primary conidium with basal papilla in water, germinating at right angles into a secondary conidium, × about 860; 6, sexual reproduction of the scalariform type (note male gametangium cut off by cross wall *w*, entering female gametangium near base), × about 600; 7, same as above at different focus to show swollen protuberance *p* of young female gametangium, cross walls *w* in vegetative cells cutting off male and female gametangia, zygotes, × about 600; 8, sexual reproduction of the lateral type, showing stalk cell *s* below the zygote and male gametangium *m*.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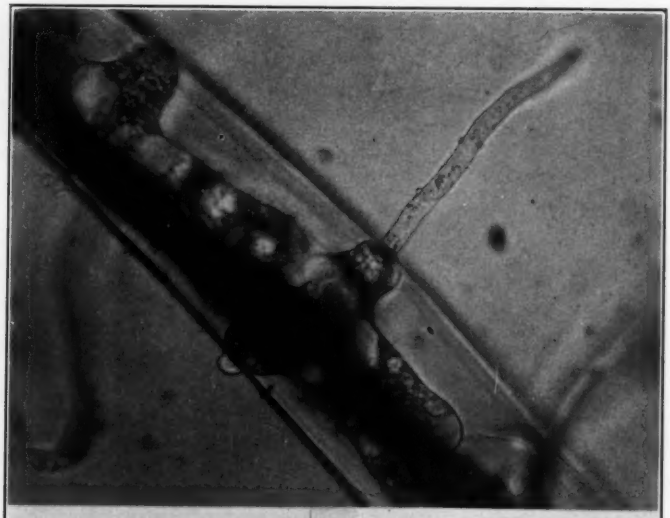
from the intramatrical cells, usually near the septa. These continue to grow outwards until they come in contact with the cytoplasmic membrane of the host cell, which may be as far distant as 15 μ from the point of their origin. The ends, pressing firmly against the membrane swell to a width of 5.5–8 μ. From them, conical papillae penetrate the membrane, push out the wall of the host cell, and emerge as the external hyphae. Often resistance encountered in forcing the wall results in a second elongated swelling between it and the cytoplasmic membrane which is then drawn back and caught between the two enlargements of the emergent hypha as shown in figure 4. The exit hyphae illustrated by Pfitzer and Dangeard, the latter especially, are more like the type found in *A. Pfeifferi* which is shown in figure 12.

On the other hand, it is not altogether improbable that Dangeard and other workers may have had the vegetative stages of both species of *Ancylistes* in the same *Closterium* cell, which would naturally have led to confusion. None of their illustrations shows both the exit hyphae of vegetative cells and the resting spores in the same desmid cell, let alone in the same thallus of *Ancylistes*. The conditions under which my fungus was found and studied militate against the confusion of *A. Closterii* with *A. Pfeifferi* in the same host cell. In the first place each fungus was found in a different species of *Closterium* which occurred in separate regions of the pool and at different times in the summer. Secondly, they were never found associated in the same culture dish. They may have existed simultaneously in the pool, but fortunately the deeper parts where *A. Pfeifferi* occurred were not explored until *A. Closterii* had nearly disappeared. However, to offset the possibility of confusion arising from the fact that they may have been present simultaneously in the pool and thus in the same desmid cell, my descriptions and measurements were taken from only

FIGS. 9–11. *Ancylistes Pfeifferi:* 9, general view of infection by external hyphae under water (observe full and empty infection cells and the number per host cell), × about 115; 10, conidiophore showing columella and conidium just discharged; the discharge took place in air, photograph taken in water under cover glass directly afterwards; the conidium to the left is still attached to conidiophore out of focus, × 600; 11, same as 10, conidia in focus, × 600.



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such thalli as showed both exit hyphae and the resting spores in the same filament.

ANCYLISTES PFEIFFERI Beck, Verh. Zool. Bot. Ges. Wien **46**: 232. 1896.

Intramatrical mycelium irregular, 7.5–14 μ, usually 9.5–11 μ, before septation; enlarged at the free ends and at intervals along the hyphae; segments or cells distinctly femur-shaped, 10.5–11.5 μ in the center, 13–19 μ at the broad ends, 9.5–12.5 μ, usually 10.5–12.5 μ, at the septa, and 43–67 μ long; segments with terminal vacuoles and several intermediate ones, and highly granular cytoplasm. Segments of external hyphae 4–7 $\mu \times$ 44.5–104 μ, average 45–70 μ long. Conidia hyaline, spherical, 21–23.5 μ in air, 22.2–30 μ with papilla in water, germ tube 4.5–5 μ; appressorium at end of infection cell disc-like, 3–4 μ, later appearing as a flat plate with a hyaline, gelatinous-like sheath which extends backward to broader part of infection cell; infection cell 7.5–13 $\mu \times$ 37–67 μ, usually 11–12 $\mu \times$ 40–55 μ; penultimate cell often very short and broad, 6–10 $\mu \times$ 9–26 μ; entrance tube penetrating appressorial plate as a fine papilla. Conjugation lateral or scalariform; gametangia cut off from vegetative cells by 1 or 2 septa depending upon their terminal or median position; male gametangium straight, narrow, sometimes with several blunt branches in cases of lateral conjugation; female gametangium swollen; cell enclosing zygote 30–40 μ, somewhat stellate with the wall extending out at intervals in 9–10 broad, bluntly truncated protuberances and separated from the main filament by a short stalk cell. Zygote or resting spore spherical, 18.5–22 μ, smooth, brown, thick-walled and filled with refractive globules; retracted from wall of enclosing cell and lying free; germination unknown.

Parasitic in species of *Closterium* in Brazil; London, Canada; and North Carolina, U. S. A.

This species is distinguished at once from the former by the more or less stellate cell in which the resting spore lies. Further-

FIGS. 12–13. *Ancylistes Pfeifferi:* 12, mature mycelium producing external hyphae (cf. fig. 4), × about 600; 13, contents of internal mycelium emptied into external hyphae, swollen tips with appressoria accidentally dislodged from host, contents then passing through appressorial plates to form further external hyphae instead of fine entrance tubes (note attached hypha *h*), × about 600.

more, even before the intramatrical hyphae become septate they show a tendency to form local enlargements along their length. With the appearance of the first cross walls pronounced joint-like bulges develop near the septa. In addition, the cytoplasm appears more granular, and the vacuoles are less conspicuously outlined. The exit hyphae develop as broad, 18.5–23 μ, lateral outgrowths which narrow to 11–15 μ just inside the host wall as can be seen from figures 12 and 13. The appressorium of the infection cell forms directly after contact is made with the host. The shrinkage of the chromatophore from the point of infection is not so marked as in *A. Closterii,* but the host cytoplasm streams with increased violence. As a reaction to the presence of the fungus, the host cell forms a definite sheath around the entry tube, as is shown in figure 16.

My observations of this species differ in many respects from the original description given by Beck. He reports that the cell around the resting spore bears six humps or broad warts, but I find 9–10 as is shown in figures 20–22. He further describes the vegetative filaments as being almost like the thallus of the genus *Myzocytium,* a string of beads composed of ellipsoidal, elongated, egg-shaped, spherical, and occasionally pear-shaped, 10–13 $\mu \times$ 12–40 μ, cells. Neither in size nor in shape are these cells comparable to those of my material, as can be readily judged from figures 12 and 13. There is a strong possibility that Beck may have been dealing with two different organisms, since I have constantly found *Myzocytium megastomum* in both species of *Closterium,* and often in association with *Ancylistes.* Figure 14 shows a bead-like filament of *M. megastomum* lying beside a filament of *A. Pfeifferi* composed of empty cells and exit hyphae. The cells of *M. megastomum,* which is here reported for the first time in America, are 9–26 $\mu \times$ 12–50 μ and show the same variation in shape as those of *A. Pfeifferi* described by Beck. In a host cell crowded with both fungi it may prove difficult to distinguish between the two species unless the observer is familiar with the life history and appearance of *M. megastomum* as well as with the significant fact that its walls and exit hyphae, in contrast to those of *Ancylistes,* give a marked cellulose reaction. That the original resting spores described by Beck relate to filaments of *A. Pfeifferi*

is apparent, since he states that they are bounded on both sides by empty cells and the thallus itself is "jointed" near the cross septa. These characteristics are shown also in my fungus in figures 19, 20 and in figure 12.

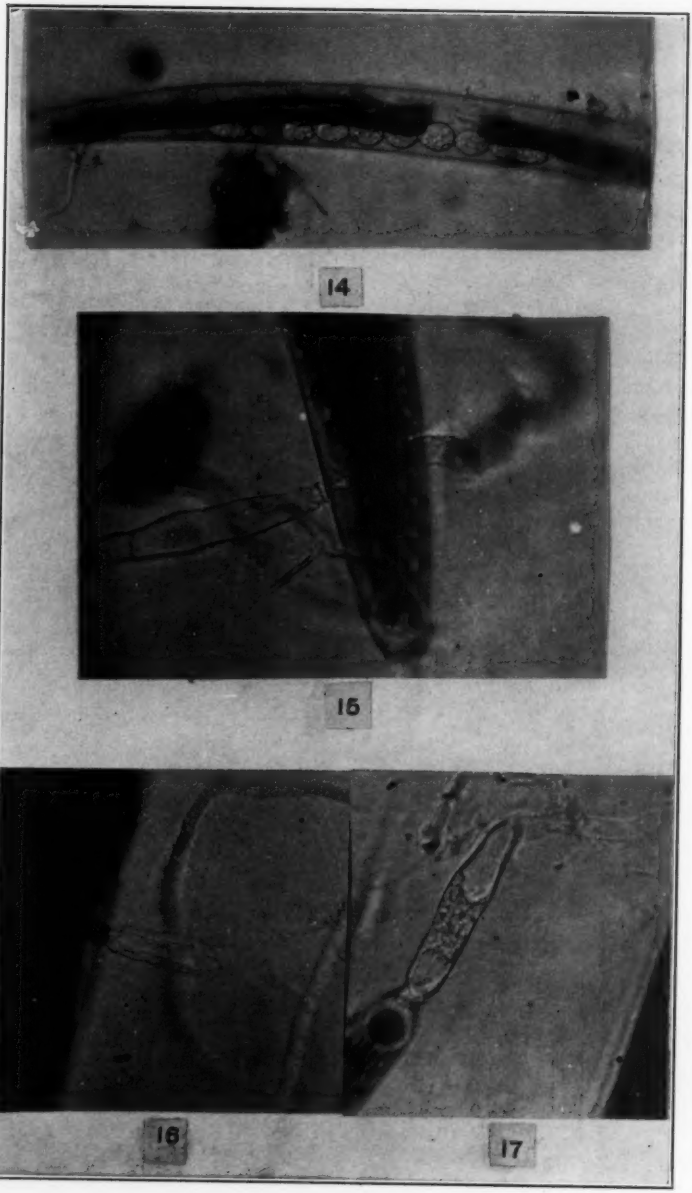
ANCYLISTES MIURII Skvortzow, Arch. Protistk. **51**: 432. *7–10*. 1925.

Intramatrical mycelium at first cylindrical, 7.4–12 μ, with hyaline, granular protoplasm, consisting of 2–5 filaments, 210–245 μ long, in a single host cell; becoming septate and divided up into 11–14 oval, bead-like cells or segments, 17.6–19 μ in length. Exit hyphae swollen, 3.7–4.2 μ, at their base and immediately inside of the host wall; external hyphae or infection tubes cylindrical and curved, 2.5–3 μ in diameter. Conidia unknown. Conjugation scalariform; male gametangium cylindrical, female gametangium barrel-shaped, 12–19.5 μ thick by 7.4–12 μ long. Resting spore lying free, spherical, 7.4–9.5 μ, hyaline, smooth, thick-walled with numerous refractive globules in the centre; germination unknown.

Parasitic in *Closterium* sp. in North Manchuria, China.

This species differs at present from the two former ones by its somewhat shorter and more oval vegetative cells, which give the mycelium a beaded appearance. In this respect it resembles the thallus of *Myzocytium*, and it is perhaps possible that Skvortzow was dealing with a species of this genus instead of *Ancylistes*. This view is further strengthened by the fact that he found no evidence of lateral conjugation. The external hyphae, which he figures, may well be elongated exit tubes for the emission of zoospores instead of incipient infection tubes or conidiophores. Until the presence of conidia, or direct infection by these tubes, as in *Ancylistes*, has been demonstrated and more is known of its type of sexual reproduction the validity of this species must remain somewhat doubtful.

Ancylistes cladocerarum Fritsch is at present so imperfectly known that its inclusion in the genus is highly problematical. The organism which Fritsch described may well belong to *Pythium* or some other similar rotifer parasite. Budde (**5**), however, lists it in his summary of rotifer parasites and calls attention to another similar fungus which Hudson and Gosse (**13**) found in *Hydatina*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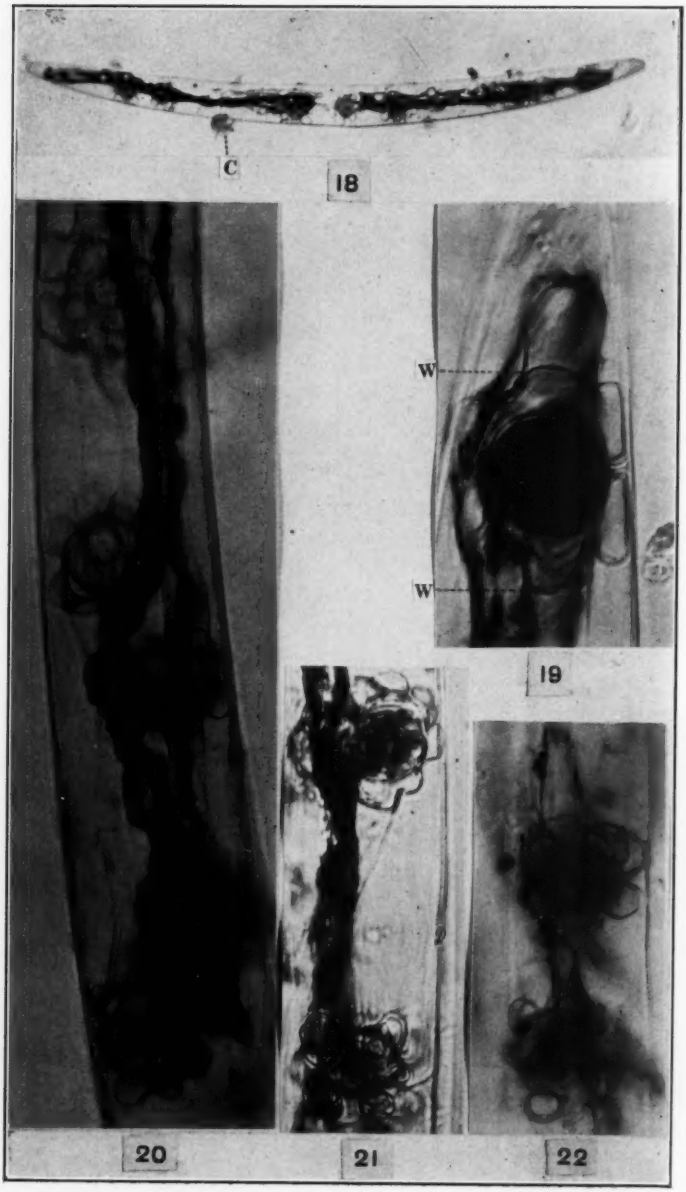
senta. An examination of their figures, however, shows at once that this parasite has nothing in common with *Ancylistes.* Voigt (**26**) also reports a fungus in the males of *Asplancha priodonata* which he thinks resembles *A. cladocerarum,* but he does not figure it.

My observations to date indicate that *Ancylistes* is homothallic. Although no monoconidial infections from separate thalli have been made, I have none the less traced the development of the male and female gametangia and the subsequent production of resting spores in a thallus which developed from a single vegetative infection tube. Figure 8 shows a part of a *Closterium* cell in which there was but one filament of *Ancylistes.* This filament began at one pole of the host cell, doubled back at the other pole, and then grew parallel to its original length. Both free ends were clearly discernible. Along these parallel strands two cases of scalariform and two of lateral conjugation took place, one of the latter being clearly shown in figure 8. *Ancylistes Closterii* is described in the literature as being heterothallic, but none of the illustrations shows conclusively that the filaments which bear the male and female gametangia respectively have developed from separate infection tubes of different thalli. Dangeard (**8**) figures the initial stages of lateral conjugation, and decries the lack of sufficient proof of heterothallism.

The use of the term zygospore for the resting spore has been avoided for the time being, although it is used extensively in the literature of the Entomopthorales. In *A. Closterii* conjugation appears to be zygomycetous, but in *A. Pfeifferi* particularly there is a tendency to contraction of the protoplast of the zygote from the wall of the enclosing cell and the differentiation of an egg cell as in the Oomycetes. It is thus possible that in this species sexual reproduction may be to some degree intermediate between the true oomycetous and zygomycetous types as has been suggested by

FIGS. 14–17. 14, bead-like vegetative thallus of *Myzocytium megastomum* de Wildeman and empty mycelium of *Ancylistes Pfeifferi,* × about 215; 15, *Ancylistes Pfeifferi:* infection cell, appressorium, entrance tube, × about 480; 16, similar to above, showing cytoplasmic (?) sheath formed about entrance tube, shrinking of chromatophore and the barely discernible protoplasmic ball poured into the host, × about 480; 17, *Ancylistes Pfeifferi:* infection at polar vacuole of host, × about 480.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Brefeld (**4**) for *Conidiobolus*. Confirmation of this, however, must await further study.

The genus *Ancylistes* is clearly a member of the Entomophthorales, and I am tentatively assigning it to a position near *Completoria complens* Lohde (**15**) which has been found parasitic in fern prothallia by Leitgeb (**14**) and Atkinson (**1**) in Europe and America.

SUMMARY

1. *Ancylistes Closterii* and *A. Pfeifferi* are reported and described for the first time from America.

2. Conidia are produced in both species by the external hyphae or so-called infection tubes whose tips emerge into the air. The conidia are forcibly discharged as in the Entomopthorales. Infection of new host cells occurs by a germ tube from the conidium.

3. The thalli of both species appear to be homothallic, conjugation being lateral or scalariform.

4. The genus *Ancylistes* is revised and removed from the Ancylistales to the Entomopthorales and tentatively assigned to a position near *Completoria.*

5. *Myzocytium megastomum* de Wildeman is reported from America for the first time.

These investigations were carried on in the Botanical Laboratory of the University of North Carolina at Chapel Hill, N. C., during the summer of 1937 under the direction of Professor John N. Couch, to whom the writer is deeply grateful for help and advice. The writer also wishes to extend her sincere thanks to the University of North Carolina and to Dr. W. C. Coker, Head of the Department of Botany, for laboratory privileges granted to her, to Dr. J. S. Karling of Columbia University for his help

FIGS. 18–22. *Ancylistes Pfeifferi:* 18, sexual reproduction (note germinating conidium *c* lying in water nearby), × about 140; 19, mature zygote in median optical view showing retraction from enclosing warted cell with two projections adpressed to wall of host (note walls *w*, *w*, cutting off female gametangium from the ordinary vegetative cell), stalk cell below zygote not visible, in Amann's solution, × about 860; 20, mature zygotes showing same as above, in Amann's solution, × about 600; 21, warted cells, surface view and median optical view, in Amann's solution, × about 480; 22, similar to 21, × about 480.

in the final revision of the manuscript and to Mr. Leland Shanor of the University of North Carolina for his assistance with the photography.

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DERMATEA ACERINA AND PEZICULA ACERICOLA [1]

J. WALTON GROVES [2]

(WITH 8 FIGURES)

The difficulty of establishing definite characters for the separation of genera in the family Dermateaceae is well illustrated by two species occurring on *Acer* and described as *Dermatea acerina* (Peck) Rehm and *Pezicula acericola* (Peck) Sacc. This paper deals with a critical study of these species in their apothecial and conidial stages, and the results obtained clearly indicate the importance of cultural work as an aid to taxonomy.

Tulasne (**1865**) was the first to point out that in the imperfect stages of *Dermatea* species the conidia are elongated to subfiliform, while in *Pezicula* species the conidia are oblong-ellipsoid. His statement was not based on cultural studies but on careful observation of associated stages. The cultural studies on this group made by the writer have supported Tulasne's statement in general, but a few exceptions have been found. For example, the gross appearance of the apothecia of *Dermatea acerina* is typical of the genus *Dermatea*, but the conidia are oblong-ellipsoid, as usually found in species of *Pezicula*. The presence of conidia of this type has led to some confusion in the taxonomy of this species and some Peziculas occurring on the same host. These studies have clarified any doubts as to its specific identity, but it may be-

[1] Contribution from the Department of Botany, University of Toronto, Toronto, Ontario.

[2] The writer wishes to express his thanks to Professor H. S. Jackson, University of Toronto, under whose direction the work was carried on, for his continued interest and helpful suggestions; to Professor H. M. Fitzpatrick, Cornell University, for his kindness in making the specimens in the Durand Herbarium available for examination; to Dr. H. D. House, New York State Museum, for his kindness in sending a portion of the type collection of *Pezicula acericola;* to Dr. F. L. Drayton, Central Experimental Farm, Ottawa, for helpful criticism of the manuscript; and to Dr. D. H. Hamly, University of Toronto, for the photograph reproduced in figure 1.

come necessary to change its generic designation when a further study is made of related forms.

Peck (**1879**) described a fungus with black, erumpent apothecia, eight spored asci, and oblong, septate ascospores, under the name *Tympanis acerina*. He noted its association with an imperfect form having oblong-ellipsoid conidia, which he had earlier described as *Sphaeronema acerinum* (**1872**).

Rehm (**1912**) transferred Peck's species to *Dermatea* since the genus *Tympanis* is characterized by having many-spored asci. He also noted its association with *Sphaeronema acerinum*, and concluded that this was probably the conidial stage.

Von Höhnel (**1916**) studied *Sphaeronema acerinum* and transferred it to *Naemosphaera* on the basis of its stromatic character. He observed its association with a *Dermatea*, but thought it was not the imperfect stage because he believed that all species of *Dermatea* had conidia of the elongated to sub-filiform type.

Seaver and Velasquez (**1933**) from a consideration of the form of the conidia, decided that *Sphaeronema acerinum* must be the imperfect stage of a *Pezicula*, and in some cases finding apothecia of a *Pezicula* on the same twigs as the *Sphaeronema* fruiting bodies, they concluded that *Dermatea acerina* was merely an old and blackened form of *Pezicula acericola*. They made ascospore cultures, presumably from the *Pezicula* apothecia, and the conidia which developed in culture were oblong-ellipsoid, but the fruiting bodies lacked the ostioles typical of *Sphaeronema acerinum*. This was interpreted as a reaction to substrate.

Archer (**1926**) studied the development of pycnidia of *Sphaeronema acerinum* in cultures obtained from conidia, and found that the ostioles might or might not be formed.

Pezicula acericola was first described by Peck (**1873**) as *Nodularia acericola*. The genus *Nodularia* Peck (**1872**) was based on a misinterpretation of *Aleurodiscus amorphus* (Pers.) Rabenhorst, and while the combination *Pezicula acericola* has been ascribed to Peck in the literature, it seems to have been first used by Saccardo (**1885**). The writer has examined two portions of the type collection of *Pezicula acericola*, one kindly furnished by Dr. House of the New York State Museum and now deposited in the herbarium of the University of Toronto, the other in the

Durand Herbarium of Discomycetes No. *6010* at Cornell University. The writer is of the opinion that more than one species of *Pezicula* may occur on *Acer*, and is using the name *Pezicula acericola* to apply only to forms agreeing morphologically with the type.

No conidial stage of *Pezicula acericola* has been described, but these studies have revealed an apparently undescribed *Cryptosporiopsis* that is undoubtedly the conidial stage of this species (FIG. 5). The fruiting bodies are extremely inconspicuous, de-

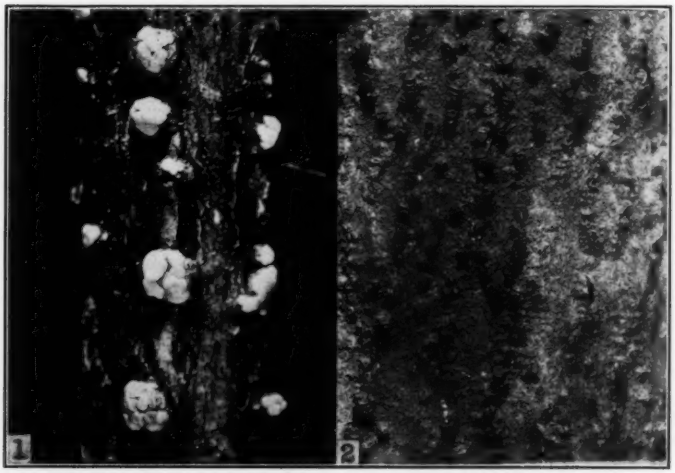

FIG. 1, *Pezicula acericola*, apothecia; 2, *Dermatea acerina*, apothecia. × 4 approx.

veloping beneath the bark and scarcely breaking through. They were first discovered by placing twigs with young apothecia in a moist chamber and the conidia emerged through cracks in the bark in masses or cirrhi.

Cultures of the two stages of both species have clearly indicated where the associations lie. The cultures from ascospores of *Pezicula acericola* and conidia of the *Cryptosporiopsis* are identical, and so also are those from ascospores of *Dermatea acerina* and conidia of *Sphaeronema acerinum*, but the two pairs differ markedly from each other. In both species the conidia are the same

shape, but in *Pezicula acericola* they are consistently larger and borne in a different type of fruiting body.

Moreover, continued field observations over a number of years have given no evidence in support of the claim that *Dermatea acerina* is an old and blackened form of *Pezicula acericola*. Apothecia of *Dermatea acerina* are black when young and immature, and remain black; while apothecia of *Pezicula acericola* when old, become somewhat darkened and crumble away, but never have the appearance or consistency of *Dermatea acerina*.

The following emended descriptions of these species and their cultural characters are based on the material used in these studies.

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Sphaeronema nigripes Ellis, Bull. Torrey Club **6**: 107. 1876.

Naemosphaera acerina von Höhnel, Fragm. zur Myk. No. 959. 1916.

Apothecia erumpent, scattered or sometimes in rows, separate or in small clusters, circular or irregularly wavy, 0.4–1.0 mm. in diameter, 0.2–0.5 mm. in height, sessile, narrowed below, black or dark brownish, hard, leathery to horny in consistency, becoming more fleshy-leathery when moist; hymenium at first concave becoming plane or slightly convex, black, the margin at first thick, raised, later almost disappearing, usually a little lighter coloured than the disc; tissue of the hypothecium compact, pseudoparenchymatous, composed of brownish, almost isodiametric to slightly elongated cells, 4–8 μ in diameter, toward the outside arranged in oblique rows with the walls thick and dark, but in the central part more elongated and interwoven; asci cylindric-clavate, short stalked, eight spored (70)–85–110–(125) $\times$ (10)–13–16 μ; ascospores oblong-ellipsoid to sub-fusiform, hyaline becoming yellowish, one to four celled, straight, sometimes slightly curved, irregularly biseriate to uniseriate, 13–20 $\times$ 5–8 μ; paraphyses hyaline, filiform, septate, simple or branched, 1.5–2.0 μ in diameter, the tips slightly swollen and glued together forming a yellowish epithecium.

Conidial fruiting bodies erumpent, usually in long rows, separate, sometimes caespitose in small clusters, subulate, basal stroma subglobose to ovoid, 0.2–0.5 mm. in diameter, dark brown to black, hard, leathery to horny in consistency, more fleshy-leathery when moist, the beak slender, tapering, straight or sometimes curved,

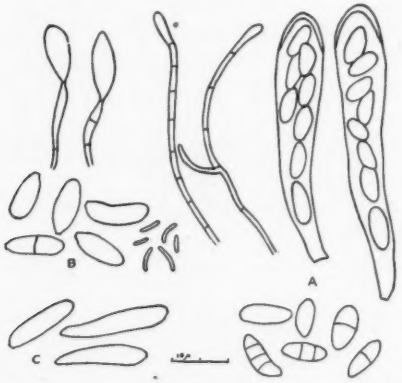

FIG. 3. *Dermatea accrina*. *A*, drawings of asci, ascospores, and paraphyses; *B*, conidiophores, conidia, and microconidia; *C*, more elongated type of conidia, occasionally occurring in culture. × 400.

brittle, up to 1.5 mm. in length and 100–150 μ in diameter at the base to 50–75 μ at the tip, dark brown to black at the base, becoming paler and often somewhat translucent toward the tip; tissue of the basal stroma pseudoparenchymatous, composed of yellowish-brown cells 5–8 μ in diameter, somewhat more elongated around the cavity, the beak composed of hyaline to pale brownish, parallel hyphae about 1.5–2.0 μ in diameter; the cavity ovoid, 150–175 × 225–250 μ, filled with numerous, hyaline, branched, hair-like paraphyses, about 1.0 μ in diameter and embedded in a slimy material; conidiophores hyaline, continuous or septate, 20–40 × 2.0 μ, swollen to 3–4 μ below the point of attachment of the spore; conidia oblong-ellipsoid, hyaline, straight or sometimes slightly curved, one celled, ends rounded, one end with a truncate apiculus, sometimes one end narrower than the other, 15–25 × 5–8 μ; microconidia not observed.

On *Acer* species.

EXSICCATI: Rel. Farl. *143;* Fungi Col. *2086, 3585;* Ellis, N. Am. Fungi *947, 3441;* Syd. Fung. exot. exs. *429.*

SPECIMENS EXAMINED: Durand, Herbarium *3022*. *Tympanis acerina* Peck, on *Acer sacch.* Griffin's N. Y. Coll. Dr. Peck. Sept. Part of type.

University of Toronto Herbarium. On *Acer saccharum*. *3524 (22)*,[3] *6563 (260)*, *7915 (396)*, *7916*, Temagami Forest Reserve, Ontario—*6109*, Peel Co., Ontario—*(128)*, Hull, Quebec.

On *Acer rubrum*. *6577 (247)*, *6958 (259)*, *7913*, *7914*, Temagami Forest Reserve, Ontario—*6562 (273)*, Toronto, Ontario.

On *Acer* sp. *3006 (71)*, *3531 (49)*, *4472*, *7281*, Temagami Forest Reserve, Ontario—*7917*, *7398 (134)*, *7399 (81)*, *8433*, Toronto, Ontario—*4839 (108)*, Ottawa, Ontario—ex. Univ. of Mich. Crypt. Herb. Coll. A. H. Povah, July 21, 1914.

Herbarium of J. W. Groves. On *Acer saccharum*. *52*, *53*, Toronto, Ontario—*316*, Temagami Forest Reserve, Ontario.

On *Acer rubrum*. *246*, *487*, Temagami Forest Reserve, Ontario—*130*, Ottawa, Ontario—*113*, Kingsmere, Quebec.

On *Acer* sp. *94*, Toronto, Ontario—*109*, Ottawa, Ontario—*463*, Lloyd Preserve, MacLean, N. Y. ex herbarium Department of Plant Pathology, Cornell University *25169*.

Mass cultures were made from both ascospores and conidia and were grown on two per cent malt extract agar and on sterilized twigs of the host. On malt extract agar the young cultures are usually green with a whitish margin. The surface is uneven, sometimes radially furrowed, and usually with many greenish to buff tufts of aerial mycelium. Later the colonies become more buff coloured or with various shades of brown, the green colour usually persisting on the margin and on the tufts. The colonies are slow growing, reaching a diameter of 1.5–2.0 cm. in one month, and often producing a brown discolouration in the medium.

Cultures such as this have been obtained repeatedly from both ascospores and conidia, but in some instances cultures from conidia have been different in appearance. The latter type are not green but grayish to brown with whitish margin, usually with a scant, cottony, aerial mycelium, not tufted. Growth is a little more rapid, but they also produce a brown discolouration in the medium.

[3] The figures in brackets refer to duplicate collections in the writer's herbarium.

The conidial stage is produced in both types of cultures, usually more abundantly in the second type. The fruiting bodies may be formed singly or with several on a basal stroma. Typical ostioles may be formed, or they may be short, or the stroma may merely split open irregularly. A variation is occasionally found in which the pycnidial stroma develops on top of a slender stalk which is

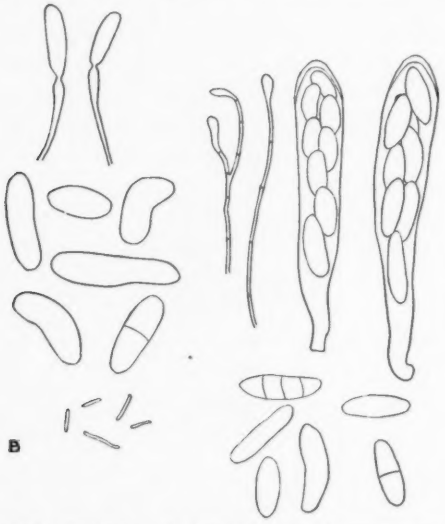

FIG. 4. *Pezicula acericola*. *A*, drawings of asci, ascospores, and paraphyses; conidiophores, conidia, and microconidia. × 400.

like the ostiole in appearance and composed of slender, parallel hyphae. Such pycnidia are very small, about 150 μ in diameter. The stalk may be up to 600 μ long and 50–150 μ in diameter. The typical pycnidia are dark brown to black, mostly about 0.5 mm. in diameter, glabrous or covered with short, brown hairs. The base of the ostiole is lighter brown, becoming hyaline or translucent toward the tip, sometimes wider than found in nature, up to 250 μ in diameter, and spread apart by the abundant spore masses. The tissue is composed of closely interwoven, brownish hyphae, mostly about 2.5–3.0 μ in diameter. In the upper part the cell walls are more thickened and grown together, forming a compact tissue. The outer cells sometimes grow out into short, brown, hair-like

hyphae. The ostiole is composed of parallel, slender, branched, hyaline hyphae, 2–3 μ in diameter. The cavity is round or ovoid, sometimes slightly chambered, and filled with a slimy material as in nature. The conidia, conidiophores, and slender paraphyses are typical, but occasionally more elongated spores, up to 35 μ in length and more or less narrowed toward one end, have been observed.

Microconidia have been found only in the green type of colony and are produced in a separate stroma. This stroma is usually minute but varies up to nearly one millimetre in diameter, at first globose, rounded, greenish, usually containing a single cavity, tearing open at the top and spreading out widely, wholly exposing the fruiting layer and green spore masses. The stroma is composed of rather loosely interwoven, hyaline or yellowish hyphae, 2.5–5.0 μ in diameter. The microconidiophores are hyaline, branched, 20–60 $\times$ 1.5–2.0 μ, bearing the microconidia terminally and laterally. The microconidia are hyaline, filiform, one celled, straight or curved, 6–10 $\times$ 1.0–2.0 μ.

On twigs of *Acer* both types of culture will produce typical pycnidia, but usually the development is better in the brown type. In the latter very little aerial mycelium is produced as a rule, except for a few whitish to brownish tufts around the point of inoculation. The fruiting bodies arise as small, erumpent, hairy, brownish, almost globose stromata. They are usually more or less in rows, mostly separate, sometimes up to four or five arising from a basal stroma. Typical ostioles may be formed, up to 2 mm. in length and 50–250 μ in diameter, or the spores may escape through an irregular split in the stroma. The conidia and other microscopic features are typical.

In the green type of culture there is usually more tendency to form excessive aerial mycelium. The twigs may become almost completely covered by a whitish to greenish, buff, or brown, cottony mycelium. It is much tufted, the tufts sometimes simulating the form of the pycnidia, but remaining sterile and of a loose, cottony structure. Typical pycnidia are, however, frequently produced. Microconidial fructifications have been observed only in the green type of culture. They are green, erumpent, occurring in rows, consisting of a stroma with a more or less irregularly chambered

cavity, which splits open at the top and spreads out becoming disk shaped. The tissue of the stroma is more compact than on agar, composed of closely interwoven hyphae with the walls somewhat thickened and grown together. The microconidiophores and microconidia are as described above.

PEZICULA ACERICOLA (Peck) Sacc. Atti. Ist. Veneto VI. **3**: 725. 1885.

Nodularia acericola Peck, Ann. Rep. N. Y. State Mus. **25**: 98. 1873.

Dermatea Alni f. *Aceris* Rehm, Rab. Krypt.-Fl. 1^3: 252. 1889.

Dermatea acericola Rehm, Rab. Krypt.-Fl. 1^3: 1245. 1896.

Apothecia strongly erumpent, thickly scattered or in long rows, caespitose in circular or elongated clusters 2–20 mm. in length, occasionally single, circular or distorted by crowding, substipitate, 0.3–1.0–(2) mm. in diameter, 0.5–2.5 mm. in height, pale yellow, slightly pruinose, becoming bright yellow when moist, brittle, rather waxy in consistency, more fleshy when moist; hymenium plane or slightly convex, pale yellow to reddish yellow, slightly pruinose, bright yellow when moist, margin forming a delicate, paler, slightly raised border, later disappearing; tissue of the hypothecium pseudoparenchymatous, composed of hyaline to slightly yellowish, irregular cells, 5–20 μ in diameter, toward the outside of the stalk the cells arranged in oblique rows and the walls thicker and darker, in the central part the tissue becoming more prosenchymatous, composed of interwoven hyphae 3–5 μ in diameter, compact at the base, more loosely interwoven in the upper part and often with intercellular spaces; subhymenium a narrow zone of rather loosely interwoven, slender hyphae; asci cylindric-clavate, short-stalked, eight spored (90)–100–125–(150) $\times$ 15–20–(24) μ; ascospores oblong-ellipsoid to ovoid, hyaline, one to four celled, straight or slightly curved, irregularly biseriate, 22.5–37.0 $\times$ 7.5–11.0 μ; paraphyses hyaline, filiform, septate, simple or branched, 1.5–2.5 μ in diameter, the tips swollen to 5.0 μ and forming a slight, yellowish epithecium.

Conidial fruiting bodies sometimes slightly erumpent, usually developing beneath the bark and splitting it but not breaking through, white to cream coloured, circular or elongated, variable in size, up to 2 mm. in length, waxy-fleshy in consistency, very variable in form, most commonly a stroma with a cavity surrounding a central, sterile, thick, cushion-like tissue, opening widely and the fruiting layer becoming more or less wholly exposed,

sometimes the central part not so much thickened and the cavities much lobed and chambered, the fruiting layer very irregular, basal stroma varying from 10–300 μ in thickness; tissue structure similar to the basal part of the apothecia which apparently arise from the central, thickened, cushion-like part of the conidial stroma, but surrounding the cavity is a zone of more or less parallel, to slightly interwoven hyphae; conidiophores hyaline, simple, continuous, sometimes septate, 10–35 $\times$2.5–3.0 μ, swollen just below the tip up to 5 μ; conidia oblong-ellipsoid, hyaline, one to four celled, straight or slightly curved, ends rounded, one end with a truncate apiculus, 25–42 $\times$ 10–15 μ; microconidia hyaline, filiform, one celled, straight or curved, 8–15 $\times$ 1.5–2.5 μ, produced in the same fruiting body as the macroconidia.

On *Acer* species.

EXSICCATI: Krieg. Fung. Sax. *1874, 2484* (as *Pezicula carnea* (Cooke & Ellis) Rehm); Rehm, Asc. *1107.*

SPECIMENS EXAMINED: *Nodularia* (*Pezicula*) *acericola* Peck on *Acer spicatum,* North Elba, N. Y. Coll. C. H. Peck. Aug. Part of the type, sent by Dr. House from the N. Y. State Museum and now deposited in the University of Toronto Herbarium.

Durand Herbarium. *6010.* Also part of the type.

University of Toronto Herbarium. On *Acer spicatum. 1403, 3529 (42), 4378 (33), 4379 (23), 5718 (152), 6572 (214), 6593 (239), 7968,* Temagami Forest Reserve, Ontario—*6582,* Parry Sound, Ontario—*6596,* Toronto, Ontario—*8440,* Sauble Beach, Ontario—Inlet, New York, Coll. H. S. Jackson, Aug. 21–24, 1934—Carter Dome Trail, New Hampshire, Coll. P. Spaulding, Aug. 31, 1928, Det. J. R. Hansbrough, F. P. *50662.*

On *Acer rubrum. 7967 (328),* Temagami Forest Reserve, Ontario.

On *Acer* sp. Salmon River, Colch. Co., Nova Scotia, Coll. L. E. Wehmeyer *1060a.*

Herbarium of J. W. Groves. On *Acer spicatum. 37,* Temagami Forest Reserve, Ontario—*116,* Ottawa, Ontario—*507,* Mt. Lake, Virginia (comm. E. K. Cash)—*561,* St. Leonard's, New Brunswick.

On *Acer pennsylvanicum. 145,* Temagami Forest Reserve, Ontario.

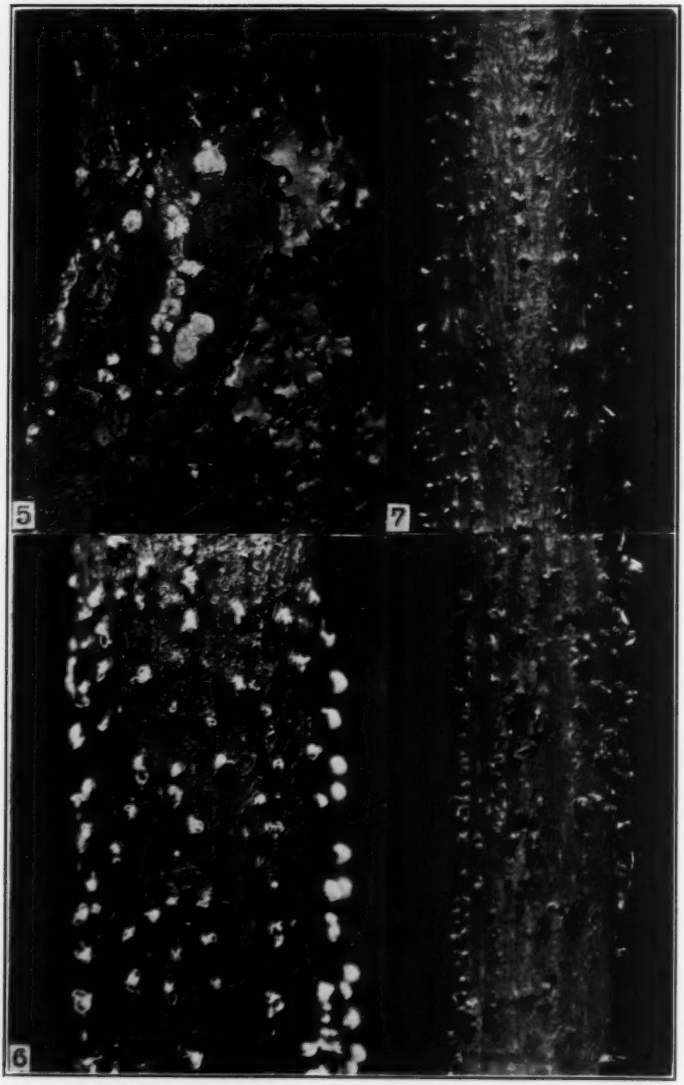

FIG. 5, twig of *Acer spicatum* with part of the outer bark removed showing fruiting bodies of the conidial stage of *Pezicula acericola;* the lichen thallus on the outer bark at the right hand side has no relation to the *Pezicula;* 6, conidial stage of *P. acericola* on twig of *Acer* in culture; 7, *Sphaeronema acerinum,* the conidial stage of *Dermatea acerina;* 8, *S. acerinum* on a twig of *Acer* in culture. All × 4 approx.

With this species also, mass cultures were made from both ascospores and conidia and were grown on malt extract agar and on sterilized twigs of the host. On malt extract agar the growth is fairly rapid, the colonies reaching a diameter of five to six centimetres in three weeks. The margin of the colony is almost colourless and closely appressed, but the rest of the colony is covered with an abundant, white, fairly loose, fluffy, aerial mycelium, often with small tufts. The conidial fruiting bodies are more or less globose to elongated, up to 3 mm. in diameter and 1 mm. in height, at first white, even, later with clear to brownish drops of liquid on them, and the mycelium becoming buff to brownish. They contain one or more irregularly lobed cavities which tear open irregularly and often quite widely. The tissue is composed of hyaline, closely interwoven hyphae, 2.5–5.0 μ in diameter, looser at the outside, sometimes pseudoparenchymatous at the base with irregular cells up to 20 μ in diameter. The conidiophores have been observed up to 50 μ in length and sometimes branched. The conidia and microconidia are typical.

On twigs of *Acer* the aerial mycelium is sometimes very abundant, completely covering the twigs, white to buff, fluffy-cottony, but sometimes only developing around the point of inoculation. Conidial fruiting bodies develop better when the aerial mycelium is less abundant. Sometimes they develop beneath the bark as in nature, and only the spore masses emerge, but usually they are erumpent, forming a white, rounded stroma on the surface of the bark, up to 2 mm. in diameter and 1 mm. in height, containing one or more irregular cavities which open widely and irregularly. The structure is microscopically similar to the form as found in nature, but with the tissue looser at the outside. The conidia and microconidia are typical.

The above conception of *Pezicula acericola* (Peck) Sacc. does not include specimens which would be referred to *P. carnea* (Cooke & Ellis) Rehm. Rehm (**1912**) and Seaver and Velasquez (**1933**) considered *P. carnea* and *P. acericola* to be synonyms, but after examination of the type and authentic specimens of *P. carnea* in the Durand Herbarium, Cornell University, the writer is of the opinion that for the present it should be considered distinct. The chief differences are that the apothecia of *P.*

acericola are more strongly erumpent, a brighter yellow, and the asci and spores are slightly larger. The specimens in Ellis, N. Am. Fungi *67a*, and in Fungi Col. *246, 3420*, labelled *Dermatea carnea* Cooke & Ellis, and the specimen in Rel. Farl. *112*, labelled *Dermatea acericola* Peck, can all be referred to *Pezicula carnea*.

In regard to host relationships, it would seem from the specimens examined that *P. carnea* occurs most frequently on *Acer rubrum*, while *P. acericola* occurs chiefly on *A. spicatum*. Comparative cultural studies of these forms are essential in order to determine whether they are distinct species or merely represent variations in the same fungus due to its occurrence on different hosts. The differences are sufficiently marked that the two types can be readily recognized and, furthermore, in the specimen in the University of Toronto herbarium No. *7967*, collected on *Acer rubrum*, the apothecia and cultures are typical of *P. acericola*. For these reasons it is considered preferable to restrict the use of the name *Pezicula acericola* as above, at least until more definite proof of the identity of *P. carnea* can be obtained.

The problem of the generic position of *Dermatea acerina* remains to be discussed. In the characters of the perfect stage, habit of growth, colour, consistency, ascus and spore characters, it would be placed in the genus *Dermatea* without hesitation. In the conidial stage, however, certain characters are widely different from those of typical conidial stages of *Dermatea* species.

The most striking of these differences is the form of the conidial spore, and in this respect its relationship would certainly seem to be with *Pezicula* rather than *Dermatea*. It is of interest to note, however, that in culture conidia are occasionally produced which are longer than usual, and show a tendency toward the elongated form of conidia of other *Dermatea* species.

Another notable difference is found in the structure of the ostiole of the pycnidium. In *Dermatea acerina* the conidial fruiting body is essentially a basal stroma containing a cavity, and having a long, beak-like ostiole. In certain other species of *Dermatea* and *Pezicula* the conidial fruiting bodies are similar in form; e.g., *Dermatea Prunastri* (Pers.) Fries, with the conidial stage *Micropera spuria* (Fries) v. Höhn., and *Pezicula pruinosa* Farl. with the conidial stage *Sphaeronema pruinosum* Peck. In both of these species,

as in *Dermatea acerina,* the ostiole may or may not be formed in culture. However, in both these species the ostiole is essentially similar in structure to the basal stroma, and is lined throughout its entire length with conidiophores, but in *D. acerina* the ostiole is different in structure from the basal stroma and the conidiophores arise only in the cavity of the basal stroma and do not line the ostiole.

Finally, in the presence of the fine, hair-like paraphyses in the pycnidial cavity, and in the production of microconidia in an entirely separate fruiting body, *D. acerina* differs from all other species of *Dermatea* and *Pezicula* as far as is known at present.

Thus in some characters *D. acerina* resembles *Dermatea,* in others *Pezicula,* and in still others seems distinct from both. It might, therefore, be desirable to erect a new genus intermediate between *Dermatea* and *Pezicula* for this species. However, cultural studies of many more species of these genera are necessary in order to demonstrate their relationships, and lacking a monographic treatment of the family, it does not seem desirable to erect new genera for isolated species which seem to be different, but of which the true relationships are none too clear, especially where it is possible to refer them to established genera. The apothecia of this species can be readily referred to, and identified in the genus *Dermatea.* Therefore, since the characters of the perfect stage are usually considered of fundamental importance in indicating relationships, it is thought preferable for the present to retain this fungus in the genus *Dermatea.*

SUMMARY

A cultural and taxonomic study has been made of *Pezicula acericola* (Peck) Sacc. and *Dermatea acerina* (Peck) Rehm and their respective conidial stages. *Pezicula acericola,* with an apparently undescribed species of *Cryptosporiopsis* as its imperfect stage, is a typical species of *Pezicula* with oblong-ellipsoid conidia. It is considered distinct from *Pezicula carnea* (Cooke & Ellis) Rehm, also occurring on species of *Acer. Dermatea acerina,* with the imperfect stage *Sphaeronema acerinum* Peck, differs from typical *Dermatea* species in having oblong-ellipsoid conidia as usually found in *Pezicula.* Its generic position is discussed but it is

retained in the genus *Dermatea* because of the characters of the perfect stage.

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CENTRAL EXP. FARM, OTTAWA, ONT.

NEW OR NOTEWORTHY FUNGI FROM PANAMA AND COLOMBIA II.

G. W. Martin

(with 34 figures)

Trichocoma paradoxa Jungh.

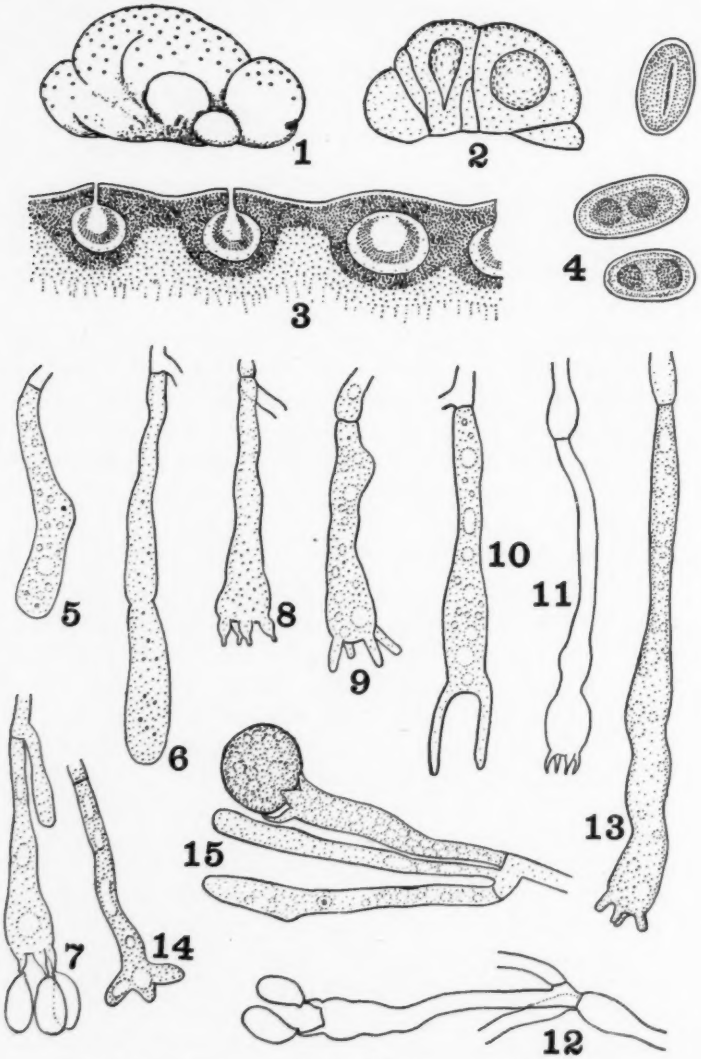
Previously reported from the west side of the volcano of Chiriquí (Mycologia **29**: 620. 1937). Another collection from the vicinity of Boquete, on the east side of the mountain, in August, 1937 (G. W. M. *4456*) suggests that this species may be not uncommon in western Panama. Like the earlier collection, this was growing on a fallen log. Boedijn states that in the East Indies it grows only on standing trunks.

Entonaema liquescens A. Möller

Originally described from Brazil, this species was later collected there by Rick. It has since been reported from Japan (Lloyd, Myc. Writ. **7**: 1167. 1922, as *E. lignescens*) and, doubtfully, from Trinidad (l. c. 1203. 1923). On the latter page Lloyd also refers to yellow Entonaemas from the southern United States and Africa as *E. splendens*, which may well be the present species. It is here reported from the Sierra Nevada de Santa Marta of Colombia, where it was found growing on dead wood along a stream on the Hacienda Cincinnati, 1250–1500 m. Aug. 11, 1935 (G. W. M. *3280*). The specimens were immature, the perithecia represented only by primordia, but the parchment-like, fawn-colored surface, spotted and streaked with orange, especially below, the gelatinous flesh and the hollow interior, filled with a blackish gelatinous fluid, leave little doubt of the determination.

Entonaema pallida sp. nov.

Stromate pallido, supra griseo-albo, infra infusco, carnoso-gelatinoso, cavo, inaequaliter globoso, basi constricto, 1–5 cm. diam., plus minus confluendo; cortice 2–3 mm. crasso; perithecis globosis, 300–450 μ diam., dispersis,



FIGS. 1–4, *Entonaema pallida;* 5–15, *Myxomycidium flavum.*

ostiolis latis, parietibus atris; sporidiis octonis, monostichis, ovoideis, atro-brunneis, 11–14 × 6–6.5 μ.

Fructification irregularly globose with constricted base, 1–5 cm. in diameter, more or less anastomosing; white to grayish above, darker below, the surface dry, fleshy-gelatinous and hollow within, the cavities filled with a watery fluid; flesh 2–3 mm. or more thick, 0.6–0.8 mm. when soaked; perithecia globose, 300–450 mm. in diameter, sparsely scattered, with broad, black ostioles; asci 8-spored, deliquescent, accompanied by slender paraphyses 150–180 μ long, 3.5 μ thick at the middle, tapering toward base and tip; spores dark brown, elliptical, blunt, nearly symmetrical, with a longitudinal slit on one side, 11–14 × 6–6.5 μ.

Panama: Canal Zone. Barro Colorado Island, Aug. 10, 1937. G. W. M. *4003*, type, on stump near termite testing ground back of laboratory. Also another collection, same locality, Snyder-Molino trail 1, Dec. 1928. W. H. Weston, somewhat immature.

Differing from all other species in color and in the widely separated perithecia, from *E. liquescens* in spore size and from *E. mesenterica* in both spore size and shape.

The excellent photograph of Weston's collection, published as *E. mesenterica* (Sci. Monthly 36: 401. 1933), shows clearly the characteristics of the present species, and its identity has been confirmed by an examination of a portion of the material which Dr. Weston has been kind enough to send me. The pallid surface, rather sparsely dotted with the perithecial openings and the dark oval spores with rounded ends are in entire agreement with the later collection, except that the spores are slightly smaller and take a pinkish stain in KOH and phloxine, a clear indication that they are immature.

In the fresh material, as shown in the sketches made at the time of collection (FIG. 1, 2), and in a section of a soaked specimen (FIG. 3) the perithecia are mostly separate and rather widely spaced. On the other hand, in material preserved in formalin-acetic-alcohol, imbedded in paraffin and sectioned by microtome, they are densely crowded, somewhat as shown in Möller's drawing of *E. liquescens* (l. c. *pl. 8, fig. 108*). The obvious explanation seems to be that this treatment has caused dehydration and shrinkage of the gelatinous stroma. Such sections do, however, emphasize the carbonaceous texture of the perithecial walls. The spores

(FIG. 4) are oval, blunt and dark brown under the lens, with a double wall and two conspicuous oil drops. On one side is a conspicuous elongated slit margined by a paler lip-like area.

The genus *Entonaema* was founded by A. Möller (Phycom. Ascom. *306*. 1901) to accommodate two Brazilian species with large ascocarps, surrounded by a dry peridium but gelatinous and hollow within, the perithecia, with carbonaceous walls, forming a parietal layer, embedded in the jelly, with only the mouths protruding, and with dark ascospores. Möller's first species, *E. mesenterica* (l. c. p. 306), to be regarded as the type, is described as dull black, with free globose perithecia and subfusiform, strongly inaequalateral, brownish black spores 10–11 × 5 μ. The second species, *E. liquescens* (l. c. p. 307) is spoken of as clear yellow and *Tremella*-like in its early stages, becoming darker with maturity because of the tendency of the outer yellow coat to be sloughed off. Möller's illustration on p. 248, often copied, is of an immature specimen which disintegrated before producing spores. The perithecia, observed in other, smaller fructifications, are densely crowded and axially elongated, the spores are oval, rounded at both ends, scarcely unilateral, 9–10 × 5–6 μ.

Patouillard (Bull. Soc. Myc. Fr. **27**: 329. 1911) reduced both *Entonaema* and the related genus *Xylocrea* Möller to synonyms of *Sarcoxylon* Cooke (Grevillea **13**: 107. 1885) of which the type is *S. compunctum* (Jungh.) Cooke, which he redescribes and illustrates. This species is scarcely an *Entonaema* in Möller's sense, but it is difficult to see wherein Patouillard's new species, *S. aurantiacum* (l. c. 331) differs from *E. liquescens*.

Lloyd recognizes four species: *E. aurantiaca* (Pat.) Lloyd, *E. cinnabarina* (Cooke & Massee) Lloyd, known respectively from the oriental tropics and Australia, *E. liquescens* Möller—sometimes spelled "*lignescens*"—and *E. splendens* (Berk. & Curt.) Lloyd, the latter his name for *E. mesenterica*, based on *Xylaria splendens* Berk. & Curt. But *liquescens* is Möller's yellow species, hence Lloyd was not justified in making this transfer, although the inference is that he did so only after examining the single immature fructification which is the type of the species inadequately described by Berkeley (Jour. Linn. Soc. Bot. **10**: 382. 1869), and deciding that it belonged in Möller's genus.

Möller placed *Entonaema* in the Xylariaceae on account of its carbonaceous perithecia and dark spores. Gäumann (Vergl. Morph. Pilze 224. 1926) places it in the Hypocreales, comparing the stroma with that of certain of the darker forms of *Hypocrea* and *Hypocrella*. Dodge accepts this in his revision of Gaumann's work (Comp. Morph. Fungi 227. 1928). But this leaves out of account the carbonaceous perithecia. This character, and the dark spores with the longitudinal fissure, are typical of the Xylariaceae, and in that family *Entonaema* should be retained.

Myxomycidium flavum sp. nov.

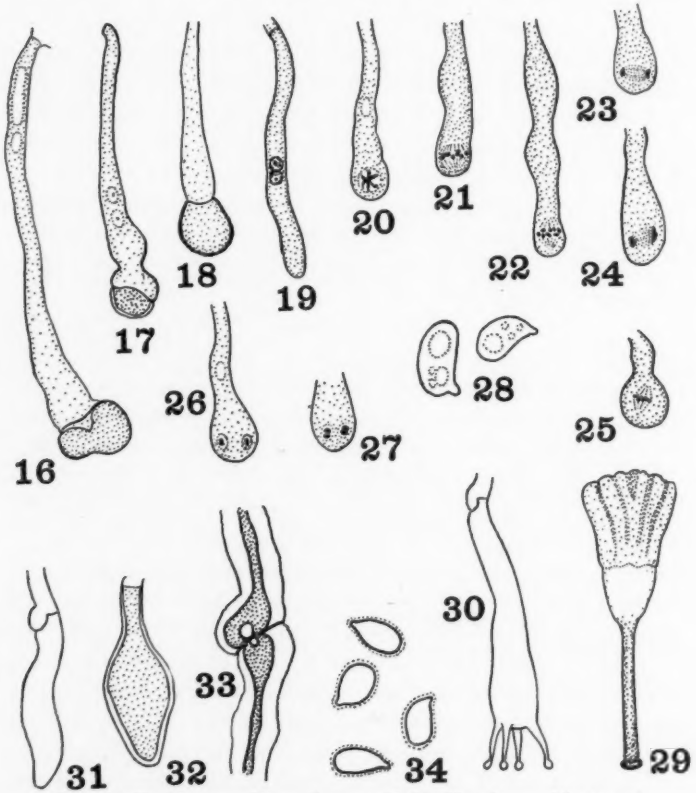
Receptacula pendula, flava, aquoso-gelatinosa, breve stipitata, lanceolata, apex acutus, 1–3.5 cm. longa; basidia clavata, 23–46 × 4.5–6 μ saepissime ex basi inflata; sterigmata 2, 3 aut 4, curvatosubulata vel cylindricata, 3–15 μ longa, 1–1.5 μ lata; sporae ovoideae vel ellipsoideae, inaequilateralibae, apiculatae, 7–11 × 3.5–6 μ.

Basidiocarp pendent, clear yellow from the first, watery-gelatinous, short-stipitate, lanceolate, with an acute apex, 1–3.5 cm. in length; basidia clavate, swollen above, 23–46 × 4.5–6 μ, frequently at maturity divided into a lower swollen portion separated from the subglobose or ovate head by a constricted central region; sterigmata, two or four, rarely three, when borne near the surface acicular, curved, short, 3 μ or more in length; when borne deeper within the gelatinous mass longer, up to 15 μ, cylindrical, resembling epibasidia; basidia accompanied by two sorts of sterile bodies, one kind basidium-like, but capped by a large, finally thick-walled vesicle, the other cylindrical and branched at the tip into two or more thick, finger-like processes; spores ovate to ellipsoid or suballantoid, apiculate, 7–11 × 3.5–6 μ.

Colombia: Dept. Magdalena. Sierra Nevada de Santa Marta, alt. 1200–1500 m. August 14, 1935, G. W. M. *3371* (TYPE) and *3509*, same region, August 19, 1935.

The specimens here described represent two collections from distinct localities, both in wet, shaded mountain ravines and both occurring on the under side of decorticated logs. No. *3371* was depending from the hollow interior of a large, much-rotted trunk lying on the ground, while No. *3509* was growing from the under side of a fallen, but scarcely rotted trunk five or six feet above the ground. The basidiocarps varied in length from less than a centimeter to 3.5 cm. and I should estimate the diameter of the largest

specimens as perhaps 6 mm. A few of the older ones were pallid, evidently because some of the pigment had been washed out, just as happens in certain species of *Dacrymyces,* but the great majority were a brilliant clear yellow, almost orange. The older and larger



FIGS. 16–28, *Myxomycidium flavum;* 29–34, *Hypolyssus Montagnei.*

basidiocarps dried down to shapeless films, but some of the younger ones, when soaked, regained their shape, but not their color. Fortunately, a few of the smaller fructifications were preserved in formal-acetic-alcohol, thus permitting imbedding and sectioning.

Soaked fragments of the hymenium, mounted in KOH and phloxine and pressed out under a cover slip, show the basidia to

be large for the genus and curiously variable. Some are clavate with a slender stalk and awl-like sterigmata, quite like the basidia of many Homobasidiomycetes (FIG. 7, 8), others are more tortuous, with more or less of a swollen base and often with cylindrical sterigmata (FIG. 9, 10). Basidia of all sorts occur in the same hymenium, but those with the hypobasidium-like bases and cylindrical sterigmata are more characteristic of the older and softer fructifications. It seems reasonable to suppose that these developments represent nothing more than adaptations to the increasing thickness of the gelatinous envelope, making it necessary for both basidia and sterigmata to be longer if the spores are to be borne at the surface.

In addition to basidia, two kinds of sterile elements are present in the hymenium. One sort consists of cylindrical or very slightly clavate hairs, simple or branched at the tip by the formation of two or more short, blunt projections (FIG. 14). The others originate in the same clusters with the basidia and are of about the same size and shape, but bear at the tip a curious vesiculose swelling, at first thin-walled (FIG. 15, 16), but later distinctly thick-walled (FIG. 17, 18). That these are modified basidia seems clear from the fact that some of them bear what have every appearance of being sterigmata (FIG. 15, 16) clasping the terminal vesicle.

Study of fixed material shows the usual sequence of nuclear phenomena. There are two nuclei in the young basidium (FIG. 19). The fusion nucleus is large and apparently persists for some time (FIG. 20). When it divides, the axis of the spindle may be longitudinal, transverse or oblique (FIG. 21–25). The chromosomes are very small, and a good plate has not been seen, but I am inclined to think their number is eight. Many of the basidia have two nuclei (FIG. 26) and some of these seem to be double (FIG. 27), but I have failed to find one with four clearly defined nuclei, although I did find one with two spindles.

The only adequate account of the genus *Myxomycidium* up to the present time is that of Linder (Mycologia **26**: 332–343. 1934). *M. flavum* is obviously close to his *M. guianense,* from which it differs in its deep yellow color, in the larger basidia and spores and in the curious sterile bodies. Dr. Linder has been

kind enough to examine my material and also to send me a portion of the type of *M. guianense*. I am indebted to him for pointing out that the subhymenium of *M. flavum* is not characterized by a broad layer of closely packed hyphae as in *M. guianense*, while the hyphae themselves are broader and are often peculiarly inflated at the apical end where the branches arise. (FIG. 9, 11, 12, 13).

Linder describes the basidia of *M. guianense* as short, but in his figure 21 shows what he regards as an abortive basidium with long, cylindrical sterigmata. His figure 17, illustrating a basidium with four nuclei, is almost exactly like the one I have drawn as with two double nuclei (FIG. 27), and I have little doubt that this really represents a four-nucleate stage.

I do not believe the much-quoted distinction between chiasto- and stichobasidia is of any fundamental significance. The orientation of the mitotic spindles is to be regarded as a mechanical response to space-relations and intracellular tension. Since the swollen tips of *M. flavum* are often approximately globular, it would seem to be possible for the spindles to be oriented in any direction, and this is apparently what happens. Nor can I agree that the swollen bases of many of the basidia are to be regarded as hypobasidia. Rather they are evidence of proliferation due to the rapid swelling of the basidiocarp, as stated above.

Linder suggests that *Myxomycidium* may be classed with the Vuilleminiaceae, a singularly dubious family, based mainly on Maire's cytological figures of *Vuilleminia comedans*. This suggestion does imply, however, that *Myxomycidium* is to be grouped with other genera of the lower Homobasidiomycetes, such as *Ceratobasidium* and *Botryobasidium*, showing clear evidence of Heterobasidiomycete affinity, and it may be accepted with that meaning, pending a rational rearrangement of the entire series, which is as yet scarcely discernible.

HYPOLYSSUS MONTAGNEI Berk.

In spite of the small size of the individual fructifications, the large number of individuals often found in a colony and the conspicuous associated mycelium make this widely distributed tropical fungus a striking species. Weston (Sci. Monthly **36**:

391. 1933) has already noted it as occurring on Barro Colorado Island, where in August, 1937, it was abundant. The generic characters are distinctive and there is little difficulty in recognizing it but the published descriptions of the species are all unsatisfactory. The best is that of Burt (Ann. Mo. Bot. Gard. **11**: 5. 1924) and the inadequacy of his description must be attributed to the poor condition of the material at his disposal. Although my most ample collection was destroyed by fire, I have three collections from Barro Colorado Island, all in good fruiting condition, and through the courtesy of Dr. C. W. Dodge, I have been permitted to examine the three specimens in the herbarium of the Missouri Botanical Garden, and nine from his personal collection. The Garden collections are from Bolivia, Mexico and Trinidad, the first two included among those studied by Burt. All are sterile and in poor condition. Four of the Dodge collections are from Costa Rica, five from Panama, in or near the Canal Zone and from both the Atlantic and the Pacific sides. Several are in fine shape. On the basis of the examination of this material I submit the following description, based on that of Burt, but with certain modifications and additions:

Fructifications gregarious, arising from a thick, irregular, ochraceous subiculum, turbinate or urn-shaped, often with flaring top, 5–18 mm. tall, 3–6 mm. broad, hard when dry, the apex sterile, convex at first, at length slightly depressed, when young covered with a pure white tomentum, which sloughs off, revealing the ochraceous top, the brown stem and the creamy hymenium, the latter covering the lower surface of the pileus at the top, and gradually extending downward, but never occupying the entire lower surface, and sharply delimited from the sterile lower part; in age, dingy white to avellaneous or cinnamon drab; stem slender, central, usually shorter than the pileus when mature, becoming brown, often with a mycelial ring at base; hymenium varying from even to ridged or sublamellate, 100–110 μ thick in section, composed of a dense subhymenium bearing clavate-cylindrical, 2–4 sterigmate basidia, with numerous fusiform, thin-walled cystidia and a few swollen, vesicular cystidia with somewhat thicker walls, neither protruding above the general surface, the whole abruptly separated from the interior of the fructification, which is composed of intricately woven, anastomosing hyphae with thick, irregular walls and narrow lumina, mostly 7–10 μ in diameter; spores oval or somewhat pip-shaped, 5–6 $\times$ 3–3.5 μ.

Massee has described two additional species of *Hypolyssus*. *H. Sprucei,* from Brazil (Grevillea **20**: 33. 1891), is said to have globose spores, 4 μ in diameter; otherwise there is nothing whatever in the description to suggest that it differs from *H. Montagnei*. *H. foetidus,* from St. Vincent (Jour. Bot. **30**: 197. *pl. 325, f. 3–5.* 1892) is described as distinguished by its fetid odor, rugulose hymenium and small, globose spores, 3 μ in diameter. Massee's figure 5 portrays the spores as irregularly globose or broadly oval. A mount from an old weathered gathering from Trinidad, No. *69932* in the Missouri Botanical Garden collection, shows an abundance of circular spores about 3 μ in diameter, but under an oil immersion objective they prove to be ascospores of the *Eurotium* type, certainly not belonging to the *Hypolyssus*. The ridged hymenium is not a specific character and the fetid odor may well have been of extraneous origin. Until evidence to the contrary can be adduced from examination of the type collections, both names should be relegated to synonymy.

The genus *Hypolyssus* itself is not in good standing. The name was proposed by Persoon (Myc. Eur. **2**: 6. 1825) for two English fungi ilustrated by Sowerby (Pls. 153, 402). Both are large, fleshy forms looking like species of *Craterellus;* both, according to Berkeley and Fries, cited by Saccardo (Syll. **6**: 521), are agarics parasitized by species of *Hypocrea*. Berkeley, in the original description of *H. Montagnei* (Hooker's London Jour. Bot. **1**: 139, *pl. 6, f. 1.* 1842), attributes the genus to Persoon and then proceeds to use it for an entirely different fungus on the ground that Persoon's genus "is altogether effete." However justifiable this may have seemed in Berkeley's time, it makes *Hypolyssus,* in his sense, a homonym under the present rules. Fries changed the generic name to *Perona* (Summa Veg. Scand. 333. 1849), although he did not actually write the new combination. Nevertheless, the correct name for this species would seem to be *Perona Montagnei* (Berk.) Fries. Since *Perona* has never come into general use, a good case could be made for the conservation of *Hypolyssus* in Berkeley's sense.

Patouillard's drawings (Essai taxonomique 132. 1900) are excellent for the habit of the species, emphasizing satisfactorily the distinction between the hymenium and the sterile base of the

pileus, completely ignored in the better-known sketch of Hennings (Engler & Prantl, ed. 1, 1 (1**) fig. 70E), which are scarcely better than Berkeley's original sketches. Since Patouillard's book is rather scarce, and the microscopic structures have never been adequately illustrated, I append a few figures. The spores (FIG. 34) are surrounded by a hyaline outer wall which is not affected by the phloxine stain and is scarcely visible under a dry lens. If this were to be included, the spore measurements would be somewhat greater than the dimensions given. The thin-walled cystidia (FIG. 31) are scarcely more than paraphyses, but their more or less fusiform shape as compared with the regularly clavate basidia (FIG. 30) suggests that they may be called cystidia.

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EXPLANATION OF FIGURES

Except figures 1, 2, 3 and 29, all outlined with camera lucide and reproduced at approximately the magnification given in each instance.

FIGS. 1–4. *Entonaema pallida.* 1, habit sketch, × 1; 2, longitudinal section, showing anastomoses and two hollow lobes, × 1: this and the preceding redrawn from field sketches made at time of collection; 3, freehand section of surface of soaked stroma, showing colorless outer peridium and perithecial layer imbedded in inner peridium, the latter rather sharply separated from the gelatinous interior, × 18; 4, three spores, the uppermost in surface view and the two lower in optical section, × 1200.

FIGS. 5–28. *Myxomycidium flavum.* 5, 6 young basidia; 7, 8 clavate basidia with short sterigmata; 9, 10, basidia with cylindrical sterigmata; 11, 12 long, semiclavate basidia arising from swollen hyphal tips; 13, unusually long basidium; 14, tip of branched paraphysis; 15, cluster of hymenial elements, one bearing a thin-walled vesicle; 16, basidium-like body bearing a thin-walled vesicle; 17, 18 thick-walled vesicles; 19, basidium just prior to fusion of nuclei; 20, fusion nucleus; 21, 22, first division, spindle longitudinal; 23, 24, same, spindle transverse; 25, same, spindle oblique; 26, two nucleate stage; 27, possible four-nucleate stage; 28, spores. All × 1200.

FIGS. 29–34. *Hypolyssus Montagnei.* 29, habit, showing ring-like foot, dark stalk, white sterile base of pileus and ridged hymenial surface, × 5; 30, basidium; 31, thin-walled cystidium; 32, thick-walled cystidium; 33, portion of an interior hypha, showing roughened, hyaline outer wall and dense lumen, and a modified clamp connection; 34, spores, with hyaline outer wall indicated. Figs. 30–34 × 1200.

THE DUAL PHENOMENON IN IMPERFECT FUNGI [1]

H. N. HANSEN

(WITH 4 FIGURES)

During the last three decades mycological and phytopathological journals have contained an increasingly large number of articles dealing directly or more commonly indirectly with variability of plant pathogenes in *Fungi Imperfecti,* in members of which group variability cannot be explained satisfactorily on the basis of Mendelian behavior. In most of the articles alluded to above it is either stated or implied that the variants in question arose in pure cultures as mutants, saltants, sports, etc., implying an exceptionally high degree of genetic instability in these fungi when grown in artificial culture media. It is the purpose of this paper to present evidence that much of the variability discussed in the literature and observed to occur in petri dishes and test tubes is not due to mutations in pure cultures but rather to the fact that many fungi as they exist in nature, though operating as definite entities, are composed of two distinct elements or individuals. This condition here referred to as the *"dual phenomenon"* is encountered with great frequency and involves many genera of the imperfect fungi.

CULTURAL EXPRESSION OF THE DUAL PHENOMENON

As a routine method of studying variation in imperfect fungi (**6**) several successive single-spore series usually consisting of 20 cultures each, are made of each fungus to be investigated. Such single-spore series of many fungi give rise to three culture types: One which is mainly mycelial in character, producing comparatively few or no conidia is called the *M* (mycelial) type. Another which produces conidia in relatively great abundance and usually less aerial mycelium is termed the *C* (conidial) type. A third type

[1] The assistance of non-technical employees of the federal Works Progress Administration is acknowledged.

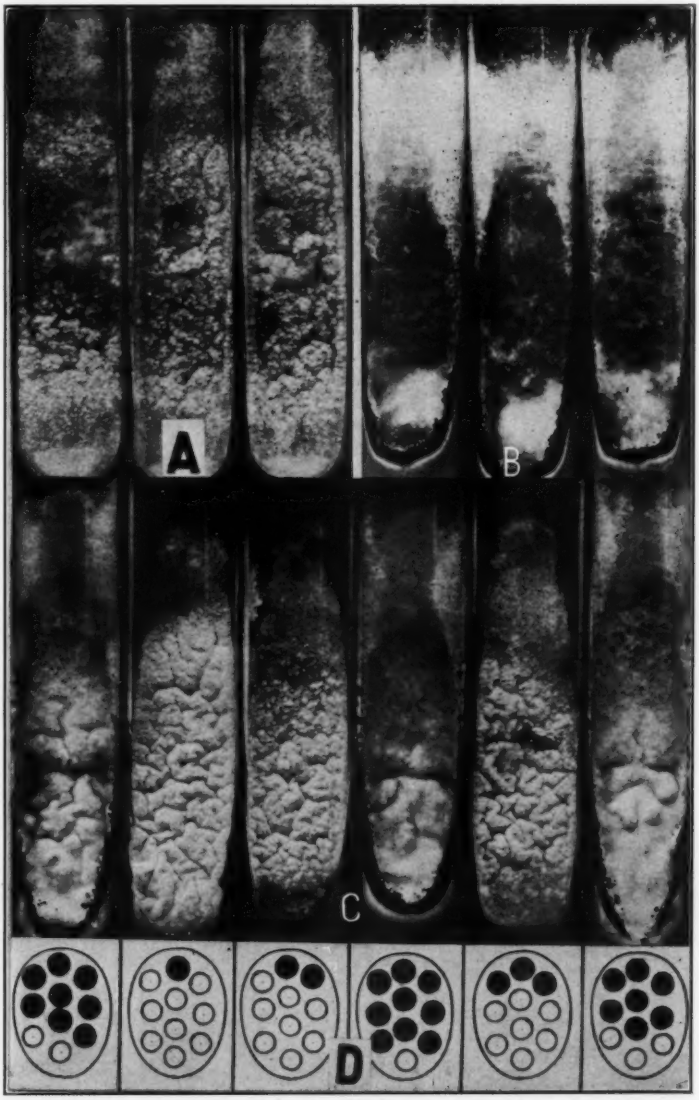
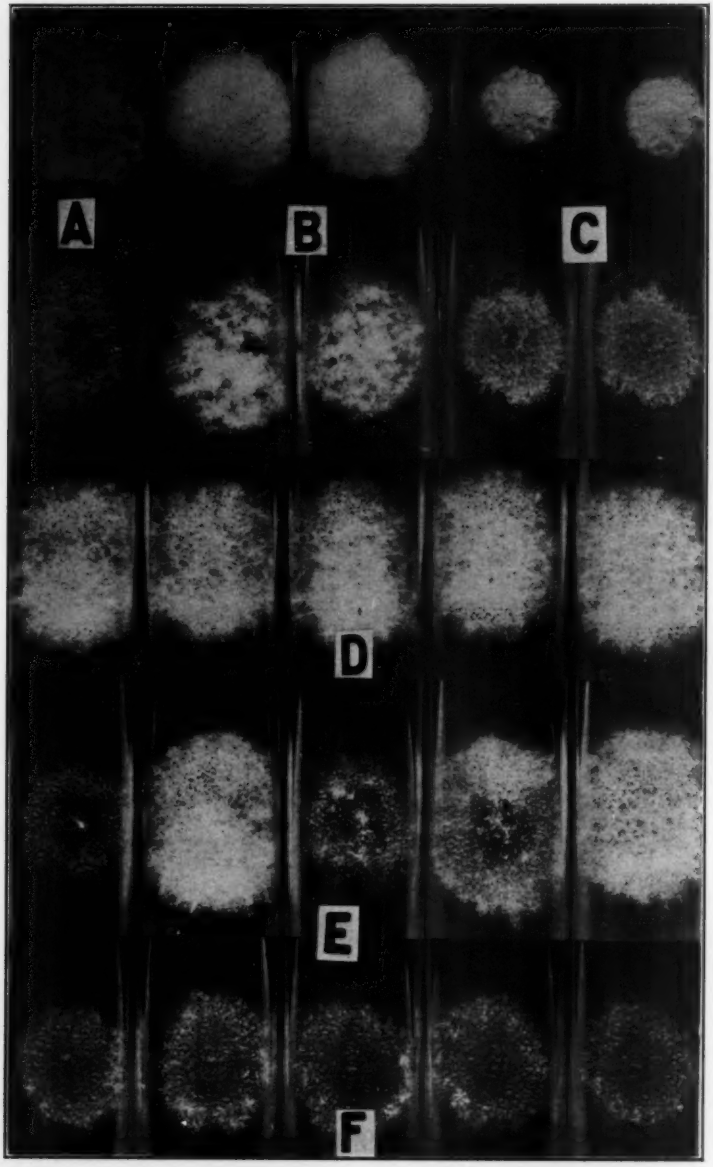


FIG. 1. An isolate of *Botrytis cinerea* showing the dual phenomenon. A, the *M* homotype. B, the *C* homotype. C, six *MC* heterotypes from a single-spore culture. D, the possible nuclear constitution of the heterotypes shown above. White representing *M*.


A
B
C
D
E
F

which in general is intermediate between *M* and *C* in production of conidia and aerial mycelium is designated as *MC*. In a preliminary note (**8**) this intermediate was referred to as *X* but since this type definitely appears to be composed of *M* and *C* the term *MC* seems to be more appropriate and will therefore be used hereafter. When the three types are analyzed by additional single-spored series it is found that *M* always gives rise to *M* types only, *C* always to *C* types only and *MC* to all three types. When *M* and *C* are grown together in mixed cultures (co-cultures (**6**, **7**)) they combine, presumably by the mechanism of anastomosis, and reproduce the *MC* type which upon single-spore analysis again gives rise to all three types.

It is to be understood that the terms *M*, *C* and *MC* were adopted mainly for the sake of convenience as they are descriptive in a general way only. Thus, for example, there is but slight difference in amount of aerial mycelium in the two types of *Verticillium albo-atrum* R. and B. shown in figure 4, though they differ materially in conidial production and can be readily distinguished on general cultural characters. The differences between *M* and *C* the two homotypes are not always merely quantitative but also may involve mycelial structure as shown in figure 3, C and E. In *Phoma terrestris* Han. the *M* and *MC* types produce pycnidia of the usual *Phoma* type whereas the *C* type produces pycnidia with beaks frequently several times as long as the diameter of the pycnidium. The three types may also differ in virulence though only a few tests have been made with *P. terrestris* on onion roots and with a few isolates of *Botrytis cinerea* Pers. on apple fruits. In the case of *P. terrestris* the virulence in decreasing order is *M*, *MC* and *C*, whereas in *B. cinerea* the order of virulence is *MC*, *C* and *M*.

CULTURAL BEHAVIOR OF FUNGI HAVING RESPECTIVELY MULTINUCLEATE, BINUCLEATE AND MAINLY UNINUCLEATE SPORES

Fungi with multinucleate spores usually give rise to several culturally distinct *MC* types that vary in appearance from nearly

FIG. 2. Three isolates of *Ascochyta Pisi* showing the dual phenomenon. A, B, and C, the *M* and *C* homotypes of three ecologic races of *A. Pisi*. D, five *M* homotypes. E, five *MC* heterotypes. F, five *C* homotypes, all from a single-spore culture of *A. Pisi*.

like *M* to almost identical with *C*. The differences in appearance of these heterocaryotic cultures are presumably due to the proportion of *M* and *C* nuclei that they possess. Figure 1 illustrates a single isolate of *B. cinerea*. At A and B are shown the two homotypes obtained after three successive single-spore series. At C are shown six *MC* or heterotypes taken from a string of 20 cultures in the second series, and at D a diagrammatic representation of what the author considers may have been the nuclear condition of the initiating spore for each culture. Subsequent analyses of these six cultures gave the following results in the next series of 20 single-spore cultures from each reading from left to right: $15C + 5MC$, $17M + 3MC$, $16M + 4MC$, $17C + 3MC$, $10M + 1C + 9MC$ and $13C + 7MC$. Stained spores of various species of *Botrytis* show that in this genus the nuclear number varies directly with spore size (volume). In the particular isolate shown in figure 1 the spores vary in size from 8 x 12 to 12 x 15 and nuclear number varies from 7 to 19. In this fungus three, four and even five consecutive single-spore series are sometimes required to bring out both of the homotypes. In *Ascochyta Pisi* Lib., the spores of which seldom contain more than 7 nuclei, there are rarely more than two distinct heterotypes (FIG. 2, E) and both *M* and *C* homotypes are easily obtained in two culture series and occasionally in one. In fungi with multinucleate spores it appears that the readiness with which the homotypes are obtained varies inversely with the nuclear number. In *Phoma terrestris* Han. which has binucleate spores there is only one *MC* type and all three types invariably appear in the first series of single-spore cultures. In this fungus the *M* and *MC* types are so nearly alike in cultural characters that they cannot be distinguished until pycnidia have formed whereas the *C* type can be recognized 48 hours after germination because of its distinct mycelial character (FIG. 3, E). In *V. albo-atrum* which produces mainly uninucleate spores it frequently happens that in the first 20-culture series only *M* and *C* homotypes are produced and additional cultures sometimes up to 50 are necessary to demonstrate that *M* and *C* nuclei can occupy the same spore. In this fungus the range of spore size is relatively much greater than in *Botrytis* and if it may be assumed that here too spore size and nuclear number vary directly it may also be as-

sumed that in *Verticillium* some spores will contain more than one nucleus and perhaps as many as three or four though this has not been definitely demonstrated. Various species of *Fusarium*, particularly those producing few or no macrospores behave similarly to *Verticillium*.

SCOPE OF THE DUAL PHENOMENON

During the past six years 916 isolates of imperfect fungi have been analyzed by the single-spore series method and of these 485 or nearly 53% were found to be dual. As shown in table 1 the dural phenomenon appears to occur more frequently in isolates from the Sphaeropsidales and Melanconiales with 70% duals than in the Moniliales with only 47% duals.

TABLE 1

FREQUENCY OF OCCURRENCE OF THE DUAL PHENOMENON IN IMPERFECT FUNGI[2]

Sphaeropsidales and Melanconiales	No. of isolates tested	No. of isolates dual	Moniliales	No. of isolates tested	No. of isolates dual
Ascochyta pinodella	8	0	*Acrostalagmus* sp.	4	2
A. Pisi	10	10	*Botrytis Allii*	4	0
A. spp.	4	3	*B. cinerea*	309	144
Colletotrichum sp.	2	1	*B.* spp.	12	5
Coniothyrium sp.	1	1	*Cephalocarpon* spp.	12	6
Cytospora spp.	14	2	*Cladosporium* spp.	4	2
Diplodia sp.	1	1	*Fusarium* spp.	139	66
Macrophoma sp.	2	2	*Heterosporium* sp.	2	2
Macrophomina Phaseoli	2	2	*Hormodendrum* spp.	7	3
Phoma terrestris	104	104	*Monilia* spp.	2	1
Phoma spp.	12	8	*Ramularia* sp.	2	1
Phomopsis Gardeniae	6	0	*Spicaria* sp.	3	1
Phyllosticta spp.	7	4	*Sporotrichum malorum*	1	1
Septoria spp.	15	9	*Trichoderma* spp.	4	1
Sphaeropsis sp.	2	2	*Verticillium albo-atrum*	183	92
Stagonospora sp.	1	1	*Verticillium* spp.	5	2
Coryneum spp.	8	3			
Gloeosporium sp.	2	1			
Myxosporium sp.	2	2			

[2] It is of course possible that some of the fungi listed here may have undiscovered perfect stages. *A. pinodella*, for example, can not readily be distinguished from *Mycosphaerella pinodes* in culture, it has the same host range, produces similar symptoms and may in fact be a stage of that fungus. Of the 14 *Cytospora* spp. listed five were isolated from material bearing perithecia of the *Valsa* type suggesting their relation to that genus.

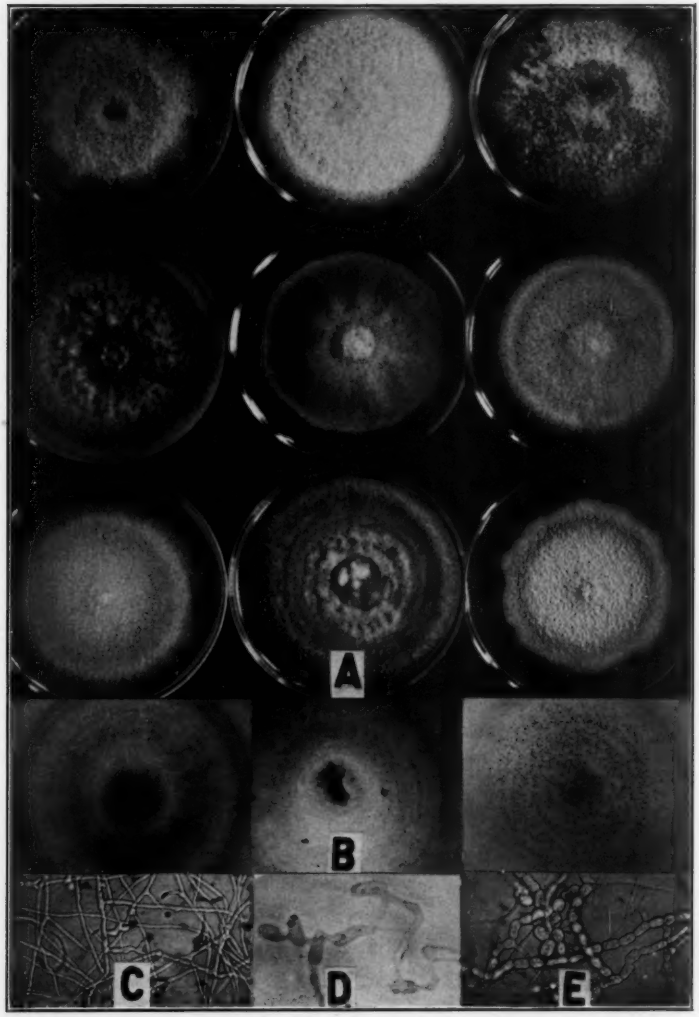


FIG. 3. *Phoma terrestris*. A, nine ecologic races. B, *M*, *MC*, and *C* types. C, mycelium from *M* type. D, anastomosing spores. E, mycelium from *C* type.

In addition to the fungi listed in table 1 the conidial stages of the following ascomycetes were similarly analyzed: Two isolates of *Diaporthe megalospora* Ellis & Ev., two isolates of *D. Sambuci* Ellis & Ev., five isolates of *Diaporthe* spp., two isolates of *Hypomyces Ipomoeae* (Halsted) Wr. (heterothallic), ten isolates of *Mycosphaerella pinodes* (Berk. & Bloxam) R. E. Stone (homothallic), eight isolates of *Sclerotinia fructicola* (Wint.) Rehm. (homothallic) and one isolate of *S. Ricini* Godfrey (homothallic). Of these 30 isolates none were found to be dual.

THE DUAL PHENOMENON AND ECOLOGICAL RACES

The rather extensive single-spore culturing of fungi performed in connection with the present investigation indicates that a species may be composed of a larger number of culturally distinct geographical or ecological races than is generally known. For example, out of some 300 isolates of *Botrytis cinerea* obtained from a wide range of hosts and from many localities in California 123 were distinct. Of about 180 isolates of *Verticillium alboatrum*, also from various hosts and localities in California, 37 were distinct races. Ten isolates of *Ascochyta Pisi* yielded 3 distinct races and of approximately 100 isolates of *Phoma terrestris* from various parts of the world 28 were distinct.

The finding of such multiplicity of races within species is of considerable interest and shows that what might be termed adaptational mutations must occur with rather high frequency in nature; but what appears to be of still greater significance is the frequent occurrence of the dual phenomenon in such races of some species and the apparently *universal* occurrence of the phenomenon in the races of other species. Thus of the 123 races of *B. cinerea* 68 were dual as were 21 of the 37 races of *V. alboatrum*. In both of the above named fungi as in most other hyphomycetes analyzed, those isolates not showing duality were predominantly of the *C* types in cultural appearance. Of the 3 races of *A. Pisi* and 28 races of *P. terrestris* all were dual. In other words these two fungi have been isolated in the *MC* or dual condition only, indicating that for them this condition is the normal or natural one.

THE DUAL PHENOMENON IN THE LITERATURE

Though the literature abounds with articles on variation in which from the data given the dual phenomenon would be the logical explanation, only a few of the more outstanding ones will be re-

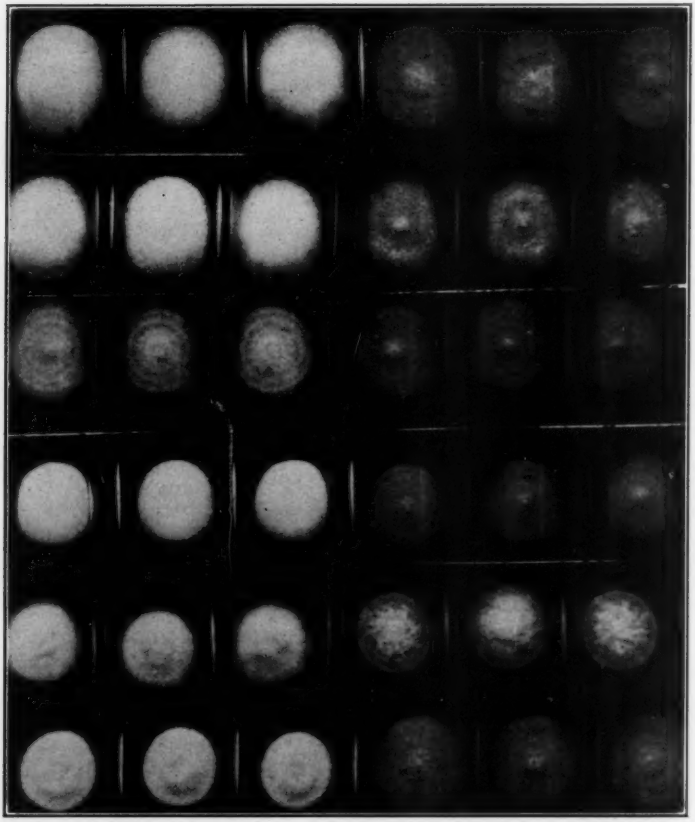


FIG. 4. Six ecologic races of *Verticillium alboatrum* showing the dual phenomenon, three *M* homotypes and three *C* homotypes of each.

ferred to here. Crabill (2) working with a *Phyllosticta* writes: "What is undoubtedly a mutation has occurred in a pure petri dish culture of this fungus. The mutant is in all respects identical

in morphological characters and physiological reactions with its parent except that it is non-fruiting." The same writer (**3**) says of *Coniothyrium pirinum* Sheld: "Two distinct strains have been isolated, viz a plus strain, which fruits abundantly, and a minus strain which fruits poorly. Attempts to determine the cause of the sporting have been fruitless." Quoting Caldis and Coons (**1**): "White variants were isolated from known single-spore cultures of *Septoria Apii, Sphaeropsis malorum, Colletotrichum lindemuthianum,* and *Cladosporium fulvum.* The variants of *Septoria Apii* and *Sphaeropsis malorum* reverted at once to the parent form—the disease produced by the *Cladosporium fulvum* variant was not like the typical disease produced by *Cladosporium fulvum.*" Roberts (**14**) found two forms of *Alternaria Mali* Rob. produced from a single-spore culture, one had abundant mycelium and few conidia and the other scant mycelium and many conidia. Mohendra and Mitra (**11**) plated spores from a single pycnidium of *S. malorum* and obtained two kinds of daughter colonies, black and white. Curzi (**4**) obtained two non-reverting saltants of *Fusarium Moronei* Curzi from a monoconidial culture. Larmer and Coons (**9**) found that of 23 single-spore isolations of *Cercospora beticola* Sacc. 15 gave rise to one or more variants. Several instances of apparent reversion was observed but always as normal sectors in the aberrant forms. Post (**13**) found that single-spore cultures of *Macrophomina Phaseoli* (Maubl) Ashby were of two kinds, one type producing pycnidia and the other failing to do so. Snyder (**15**) by mass-transfers from sectors in a monospore culture of *F. orthoceras* App. & Wr. var. *Pisi* Linford succeeded in obtaining two apparently constant forms (see his fig. 5). In Leonian's work on variation in *Fusarium* (**10**) plates 16–19 and 25–32 are all most excellent illustrations of the dual phenomenon. These forms were also obtained by mass-transfers from sectors and many of them showed reversion later on. Had Leonian used single-spore series instead of mass transfers his conclusions would probably have been quite different. Nelson *et al* (**12**) obtained two pathogenic forms of *Fusarium* from celery: *F. Apii* Nelson and Sherbakoff and *F. Apii* var. *pallidum* Nelson and Sherbakoff. The writer wonders if they are not also merely the *M* and *C* forms of the same fungus, *F. Apii.*

DISCUSSION AND CONCLUSIONS

The regularity and completeness with which the *M* and *C* homotypes separate from the *MC* heterotypes, whether obtained directly from nature or produced in co-cultures indicate that the elements which determine cultural, morphological and physiological characters are discrete units, limited in number, namely the nuclei. The evidence suggests further that the *nucleus* rather than the *cell* is the basic unit of the individual. In other words a plurinucleate spore is not an individual in the true sense of the word but a group of individuals and it cannot give rise to a genetically pure culture unless all the nuclei it contains are genetically identical. The relative difficulty or ease with which the homotypes are obtained from dual fungi having, respectively, multi, bi, or mainly uninucleate spores further substantiates the above and indicates that the dual phenomenon is due to a conditions of heterocaryosis.

The fact that each of the fungi analyzed was composed of only *two* homotypes would suggest that the dual phenomenon is not merely an expression of genetic instability but rather an indication that duality is the *normal* condition for these fungi. The frequency with which fungi were isolated in the *MC* form further suggests the normality of this condition. Certainly for *A. Pisi* and *P. terrestris,* of which all isolates were found to be dual, that condition must be considered the normal one, and it is not improbable that duality is also normal for the other fungi tested for although only about 50% of them were isolated in the *MC* condition it is highly probable, since separation in culture is readily brought about, that separation occurs in nature also and that therefore many of the fungi isolated as homotypes had arisen in this manner. The cohesive nature of the spore-mass and the fact that the spores of many members of the Sphaeropsidales anastomose readily (FIG. 3, D) would greatly minimize the possibility of distribution of individual spores and may explain why homotypes are found less often in this group than in the hyphomycetes. Of the 30 conidial isolates from several species of perfect fungi none were found to be dual suggesting that duality is probably not connected with former + or — sex forms though duality might be considered to compensate in a measure for loss of sex functions, for

undoubtedly an *MC* fungus has the advantage of greater flexibility over either of its components.

As has been suggested earlier (**8**) the dual phenomenon may well be analogous to the well-known Rough and Smooth in bacteria with this difference, however, that according to the majority of investigators (**5**) (working mainly with mass-transfers) bacteria may change rather readily from one form to the other whereas *M* and *C* homotypes kept in culture for more than six years are still true to type.

Though an adequate explanation of the function of the dual phenomenon is not offered it is suggested that certain behaviors such as sectoring, reversions, loss of ability to sporulate, change in virulence, etc., frequently observed to occur in fungi under artificial culture condition may in many cases best be explained on the assumption that the fungi were obtained from nature in the dual heterocaryotic condition with subsequent dissociation (separation) of the homotypes. It rather appears that the dual phenomenon has a deeper significance and a wider application than was suggested for heterocaryosis by Hansen and Smith in 1932 (**6**).

It is the writer's opinion that the failure of workers in general to make use of single-conidium technics beyond that of procuring pure cultures is responsible for the tardy recognition of the dual nature of so many imperfect fungi.

SUMMARY

1. When some 900 isolates from 30 genera of imperfect fungi were analyzed by the single-spore series method it was found that more than 50% of them were dual, *i.e.* were composed of two culturally distinct individuals. This condition is referred to as the "dual phenomenon."

2. Such dual fungi when single spored give rise to three culture types: One producing abundant mycelium and few conidia is called the *M* (mycelial) type, another producing many conidia and relatively less mycelium is termed the *C* (conidial) type and a third type in general intermediate between *M* and *C* in cultural

characters is named *MC* suggesting that it is composed of the other two types.

3. *M* and *C* when single-spored give rise to *M* and *C* types only, whereas when *MC* is single spored it gives rise to all three types. When the homotypes *M* and *C* are grown together in mixed culture they combine, presumably by the mechanism of anastomosis, and produce the *MC* type which upon single sporing again gives rise to all three types *M, C* and *MC*.

4. The above indicates that the dual phenomenon is due to heterocaryosis *i.e.* that individual cells and individual spores of dual fungi contain two genetically distinct types of nuclei, this is further substantiated by the relative difficulty or ease with which the homotypes *M* and *C* are separated from *MC* heterotypes having multi, bi or mainly uninucleate spores.

5. The frequency with which the dual phenomenon is observed to occur in imperfect fungi suggests that duality may be the natural condition for many of them.

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CYTOLOGICAL OBSERVATIONS ON GAMETOGENESIS AND FERTILIZATION IN ACHLYA FLAGELLATA

FRED T. WOLF

(WITH 9 FIGURES)

INTRODUCTION

The processes of gametogenesis and fertilization within the genus *Achlya* Nees have long been the subject of controversy. Humphrey (**1892**) concluded that in *Achlya americana* no nuclear divisions occur within the oögonia or antheridia. The young oögonium contains many nuclei. The decrease in number, so that only one nucleus remains for each oösphere to be formed, was thought to result from the repeated fusion of nuclei in pairs. Although antheridial tubes are formed which penetrate the oöspheres, they remain closed, and fertilization does not occur. In the few cases observed of binucleate oöspores, it was concluded that both nuclei were of oögonial origin, representing one of the last stages in the process of endogenous fusion.

Hartog (**1895**), working with *A. polyandra* Hildebrand, *A. apiculata,* and *A. recurva,* agreed with Humphrey that the decrease in the number of oögonial nuclei during gametogenesis results from repeated nuclear fusions, and that antheridia in this genus are non-functional. Working entirely with material stained and mounted *in toto,* it seems remarkable that he was able to demonstrate the existence of a nuclear division within the oögonium, and to recognize the presence of four pairs of chromosomes at the equatorial-plate stage.

Trow (**1899**), having found that fertilization occurs invariably in *Saprolegnia dioica* deBary (*S. diclina* Humphrey) and also in *S. mixta* in all cases in which antheridia are present (**1895**), studied gametogenesis and fertilization in *Achlya americana* var. *cambrica.* In this form he found that the gametangial nuclei divide mitotically; the spindle is intranuclear and the chromosome number

probably four. The reduction in the number of oögonial nuclei occurs not by fusion, as maintained by Humphrey and Hartog, but by the degeneration of supernumerary nuclei. Antheridial tubes were observed to penetrate the oöspheres; each opens to discharge a single nucleus, smaller than that of the oösphere. The antheridial nucleus, after remaining near the periphery of the oösphere for a time, eventually fuses with the oösphere nucleus.

Trow (**1904**) extended these results to *A. polyandra* Hildebrand and *A. Debaryana* Humphrey (*A. polyandra* deBary). In both species fertilization was observed. In *A. Debaryana,* which was the more thoroughly studied, Trow concluded that two nuclear divisions occur within the oögonium, in consequence of which the chromosome complement is reduced from eight to four. His previous observations as to the degeneration of supernumerary oögonial nuclei were confirmed. Centrosome-like bodies and astral radiations were observed in association with the gamete nuclei.

Mücke (**1908**) reinvestigated gametogenesis and fertilization in *A. polyandra* deBary, previously studied by Trow. Mücke found that only one division occurs in the oögonia and probably also in the antheridia; the chromosome number is more than eight. Although the discharge of an antheridial nucleus from the antheridial tube into the young oösphere was observed, the question as to whether or not a subsequent nuclear fusion occurs remained unanswered.

In *A. colorata,* Patterson (**1927**) found that a single mitosis occurs within the oögonium. The chromosome number is perhaps three. Following the disintegration of supernumerary nuclei and the formation of oöspheres, a nucleus is discharged from the antheridial tube which eventually fuses with the oösphere nucleus.

Mäckel (**1928**), incidental to a cytological study of other members of the Saprolegniaceae, made some observations on the nuclear divisions within the oögonia of *A. Debaryana* and *A. prolifera.* Eleven chromosomes were found in each species.

Cooper (**1929***a*) found that fertilization occurs in *A. hypogyna.* Although there is no doubt that in this species the antheridial tube discharges a nucleus into the oösphere, no illustrations are presented to show that, as Cooper concluded, the gamete nuclei subsequently fuse.

In Miss Carlson's (**1929**) cytological study of gametogenesis and fertilization in *A. racemosa*, it was shown that a nuclear fusion occurs in this species.

Raper (**1936**) found in *A. bisexualis* that the antheridial tubes frequently penetrate the oöspheres, and that the latter are occasionally binucleate. While the available evidence indicates that fertilization occurs, his observations are too incomplete to justify a definite conclusion upon this point.

MATERIALS AND METHODS

The present study is concerned with the processes of gametogenesis and fertilization in *Achlya flagellata* Coker. In his description of this species, Coker (**1923**) mentions the fact that the antheridial tubes are easily observed. Material was collected by Dr. E. M. Gilbert in Lake Windigo (Bass Lake), Sawyer County, Wisconsin, on May 29, 1936, and identified by Dr. J. N. Couch.

Cultures of the organism were maintained on boiled hemp seed in distilled water. Observations on living material showed that sexual organs are produced in abundance, and that the antheridial tubes are readily visible. On certain of the older oögonia, the antheridia appeared to be collapsed and empty.

A considerable variety of fixatives were tested. Best results were obtained with a mixture of 0.3% chromic acid and 0.7% glacial acetic acid, diluted with distilled water until, as determined by experiment, plasmolysis was reduced to a minimum. After embedding in paraffin, sections were cut 5 μ and 10 μ in thickness.

In staining, the reagents used by Couch (**1932**) in his study of *Leptolegnia caudata* were employed, but with considerable modifications of his schedule. After the paraffin was removed from the slides with xylol, they were transferred to absolute alcohol and passed through a graded series of alcohols to water. The remaining steps in the process were as follows:

1. Iodine-potassium iodide solution, 5 minutes; wash in water for a few seconds.
2. Crystal violet solution, 30 seconds to 5 minutes; wash in water.
3. Iodine-potassium iodide solution, a few seconds; wash in water.
4. Flood slide with 95% alcohol and drain.

5. Flood with a saturated solution of picric acid in 95% alcohol and drain.
6. Flood with absolute alcohol.
7. Destain further in clove oil until the desired color intensity is obtained.
8. Clear in xylol, and mount in balsam.

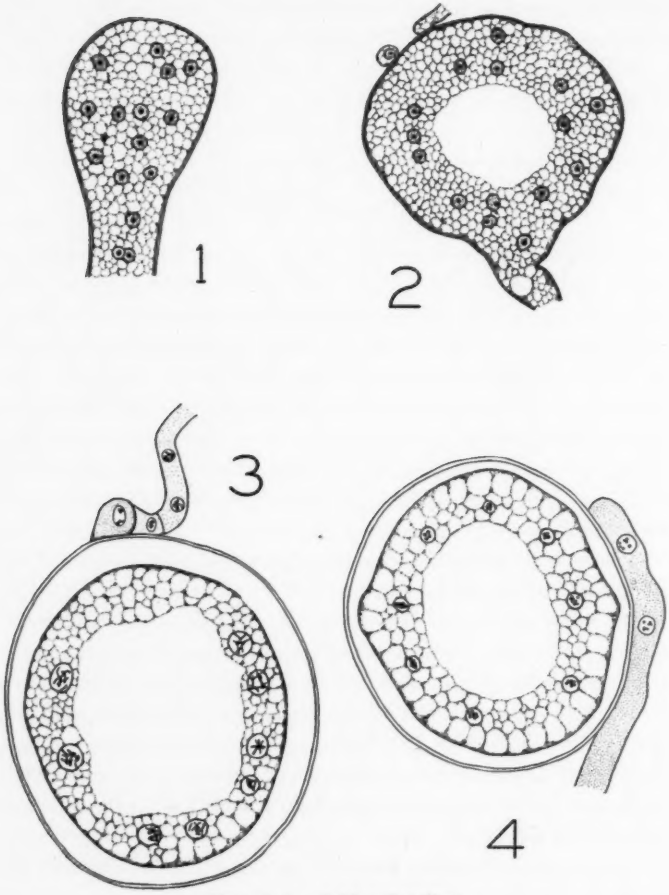
OBSERVATIONS

The oögonia are produced terminally, on short lateral branches of the main hyphae. The distal end of a lateral branch becomes enlarged; this young oögonial initial is filled with dense cytoplasm and contains many nuclei (FIG. 1). The cytoplasm is highly vacuolate and contains numerous deeply-staining mitochondria. The nuclei at this stage do not differ in appearance from vegetative nuclei. They are small, about 2.5–2.8 μ in diameter, and contain a conspicuous central nucleolus as well as a faintly-staining chromatic network. Occasionally, several deeply staining strands are seen radiating from the nucleolus.

Soon a large vacuole appears in the center of the oögonial initial, and the nuclei and dense cytoplasm become limited to a rather thin peripheral region (FIG. 2). At about this time one to several antheridial branches appear, sometimes from the main hypha which bears the oögonium (an androgynous condition), or more often from a large distant hypha (a diclinous condition), and become applied to the surface of the oögonial initial. These antheridial branches are considerably smaller than either the hyphae which bear them or the oögonial stalks, but otherwise are structurally similar.

The immediately succeeding changes could not be traced in the material available. It may be expected, however, from analogy with what is known of other members of the genus, that the central vacuole of the oögonial initial would become continuous with the central vacuole of the oögonial stalk. Presumably cell division then occurs, separating the antheridium and oögonium from their parent hyphae, and partition walls are laid down.

The oögonial nuclei in early prophase enlarge considerably, attaining diameters of 3.5–4 μ. During the prophases (FIG. 3), the nucleolus disappears and the nucleus comes to contain an in-



FIGS. 1–4. *Achlya flagellata.*

determinate number of densely-staining chromatic strands. There appears to be no continuous spireme.

In the oögonium shown in figure 3, the antheridial nuclei are already in the anaphases and those of the oögonium are still in prophase. These facts are not in agreement with previous statements that nuclear divisions in the oögonium and antheridium are simultaneous.

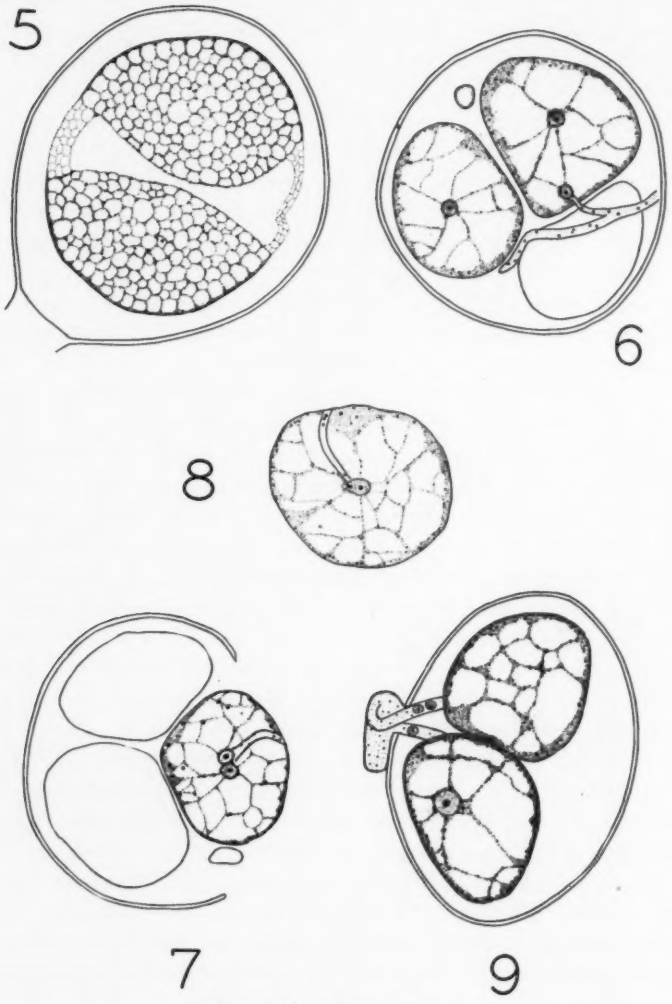
The spindle is intranuclear (FIG. 4). By the time the chromosomes have reached the equatorial plate, they have undergone much constriction. In the particular oögonium shown in figure 4, some of the nuclei are in the equatorial plate stage, some in the anaphases. Four chromosomes are clearly present in some of these nuclei, eight in others, and all counts have shown numbers between four and eight. It seems fairly certain, therefore, that four is the chromosome number, counts of eight indicating that daughter chromosomes have already separated. The nuclear membrane persists until late anaphase.

Our evidence indicates that only one nuclear division occurs within the oögonium and one in the antheridium. This division is to be interpreted as an ordinary mitosis.

Following mitosis within the oögonium, it is to be expected, from work on other species, that many nuclei disintegrate, only one remaining for each future oösphere. In only a few instances were stages in nuclear disintegration and oösphere formation seen. In figure 5, in which no nuclei appear because the section shown is not median, it may be seen that the peripheral layer of cytoplasm and nuclei within the oögonium has begun to thicken in certain places, and to decrease in thickness between the oösphere origins. Eventually the contents of the oögonium become divided into from two to six oöspheres. Each oösphere is approximately spherical, 26–35 μ in diameter (FIG. 6), and contains a single centrally-located nucleus, whose diameter is 2.5–3 μ.

When the oöspheres have been fully formed, multinucleate antheridial tubes extend from the antheridium, penetrate the oögonial wall, and grow in between the oöspheres. A tube penetrates the membrane of an oösphere and opens at its tip to discharge a single antheridial nucleus and a small quantity of cytoplasm into the oösphere (FIG. 6, 7). In some cases the antheridial tube extends but a short distance into the oösphere, so that the discharged male gamete nucleus remains for a time in the periphery of the oösphere. In other instances, the antheridial tube extends to the center of the oösphere, and discharges its nucleus in close proximity to the female gamete nucleus.

In the antheridial tube shown in figure 6, it could not be determined whether the male gamete nucleus had been discharged from



FIGS. 5–9. *Achlya flagellata.*

the antheridial tube or not. The fact that, as in this case, the diameter of the male gamete nucleus within the oösphere is often greater than that of the antheridial tube indicates that the nucleus probably increases in size until it is freed by rupture of the tube. After becoming free, the male gamete nucleus appears to enlarge further until its size is equal to that of the oösphere nucleus.

The two nuclei come in contact and eventually fuse. At one stage in this process (FIG. 8), the fusion nucleus contains two nucleoli. Eventually the process of nuclear fusion is completed (FIG. 9), and each oösphere, now an oöspore containing a single large nucleus, surrounds itself with a thick wall.

DISCUSSION

After considerable progress had been made in this investigation and most of the drawings had been completed, attention was called to the work of the Moreaus (**1935**), who had previously made a cytological study of *A. flagellata*. No drawings are presented in support of their findings, which, while essentially in accord with our own, do not agree in a number of details. According to the Moreaus, the antheridial and oögonial nuclei undergo a simultaneous division. This was certainly not the case in the present material.

The Moreaus find that a centrosome-like body and astral radiations are associated with the oögonial nuclei which are destined to form oöspheres. This we have been unable to observe.

Although the Moreaus followed the development of *A. flagellata* up to the stage at which the oöspheres are binucleate, and the two nuclei are in contact, nuclear fusion was not observed, and they suggest that if it occurs, it is postponed, perhaps until the germination of the oöspore. There is no doubt but that nuclear fusion in *A. flagellata* occurs at about the time when the oösphere is being transformed into a thick-walled, resistant oöspore.

Most investigators have reported that the nuclear divisions within the oögonium and antheridium occur simultaneously. Shanor (**1937**) found in *Thraustotheca clavata* that the division of the oögonial nuclei precedes that within the antheridium. In *Achlya flagellata* the reverse condition is apparently realized, nu-

clear divisions in the antheridium occurring in advance of those in the oögonium.

The development of the sexual organs and the process of fertilization in the Saprolegniaceae show a striking degree of uniformity among the various species of the group which have so far been studied in this respect. Hitherto, the following forms have been examined cytologically: *Achlya americana* var. *cambrica* (Trow, **1899**), *A. polyandra* Hildebrand (Trow, **1904**), *A. Debaryana* (*A. polyandra* deBary) (Trow, **1904**; Mücke, **1908**), *A. colorata* (Patterson, **1927**), *A. hypogyna* (Cooper, **1929a**), *A. racemosa* (Carlson, **1929**), *A. conspicua* (Moreau and Moreau, **1935**), *A. flagellata* (Moreau and Moreau, **1935**), *A. bisexualis* (Raper, **1936**), *Saprolegnia dioica* deBary (*S. diclina*) (Trow, **1895**), *S. mixta* (Trow, **1895**; Davis, **1903**), *S. monoica* (Claussen, **1908**), *S. ferax* (Höhnk, **1935**), *Aphanomyces laevis* (Kasanowsky, **1911**), *Brevilegnia diclina* (Cooper, **1929b**), *Leptolegnia caudata* (Couch, **1932**), and *Thraustotheca clavata* (Shanor, **1937**).

With the exception of Trow (**1904**), who claimed that two nuclear divisions occur within the oögonium of *A. Debaryana* and suggested that this might also be the case in *A. polyandra* Hildebrand, all investigators have agreed that only one nuclear division takes place. It becomes apparent, therefore, as was suggested by Claussen (**1908**) and has been assumed by most subsequent workers, that meiosis cannot occur during gametogenesis, and probably is to be found during oöspore germination. Cytological proof of this is, however, lacking, due to the difficulty in inducing the oöspores of many species to germinate readily, as well as in securing adequate fixation of the oöspores after the formation of a thick, relatively impermeable wall.[1]

The chromosome numbers which have been reported for members of the family range from one in *Saprolegnia dioica* and *S. mixta* (Trow, **1895**), to eleven in a number of species (Mäckel, **1928**), 10–14 in *Saprolegnia monoica* (Claussen, **1908**), and 12–18

[1] Since the completion of this paper, Schrader (Die Entwicklung von *Thraustotheca clavata*. Flora, N. F. **32**: 125–150, 1938) has published evidence, based upon nuclear size, indicating that meiosis occurs in *Thraustotheca clavata* during oöspore germination.

in *Aphanomyces laevis* (Kasanowsky, **1911**). Exact counts have been rendered difficult or impossible by the exceedingly small size of these structures. It is perhaps significant, however, that four chromosomes have been reported for *Achlya* spp. by Hartog (**1895**), *A. americana* var. *cambrica* by Trow (**1899**), *Saprolegnia mixta* by Davis (**1903**), *Achlya Debaryana* by Trow (**1904**), *A. conspicua* and *A. flagellata* by Moreau and Moreau (**1935**). Our material of *A. flagellata* confirms the findings of the Moreaus with this species.

The presence of a centrosome-like body and astral radiations in association with the nuclei of the sexual organs has been reported in a majority of the species investigated. These structures appear to be especially conspicuous in *Leptolegnia caudata* (Couch, **1932**) and *Thraustotheca clavata* (Shanor, **1937**). Our failure to observe centrosomes and astral radiations in *A. flagellata*, in which they had been observed by the Moreaus, as well as the supposed absence of these structures in a number of other species is perhaps to be attributed to differences in the methods of fixation and staining employed. In no case in this group have "centrosomes" been shown to originate by the division of a pre-existing one. Höhnk (**1935**) reports astral radiations but no centrosome in *Saprolegnia ferax*, while according to Raper (**1936**), *Achyla bisexualis* apparently has centrosomes but not astral radiations. Further work is needed before the significance of these structures, especially in the process of oösphere formation, can be regarded as established.

SUMMARY

The development of the sexual organs of *Achlya flagellata* is similar to that in other members of the genus. A single mitotic division occurs within the oögonium and antheridium. The chromosome number is probably four.

Fertilization occurs in *A. flagellata* by the discharge of a single nucleus from the antheridial tube into the oösphere. The male gamete nucleus subsequently fuses with that of the oösphere.

This investigation was carried out under the direction of Dr. E. M. Gilbert, who has been of assistance in numerous ways, and supported by a fellowship from the Wisconsin Alumni Research

Foundation. The writer is also indebted to Dr. C. E. Allen for his advice and interest in the problem.

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EXPLANATION OF FIGURES

All drawings were made with the aid of an Abbe camera lucida, using a 10 × ocular and 1.8 mm. objective, at table level. Original magnification, 1800 ×; reduced about one half in reproduction.

FIG. 1, young multinucleate oögonial initial; 2, young oögonial initial, showing central vacuole, peripheral arrangement of nuclei, and antheridial branches; 3, section of oögonium, showing prophase of nuclear division; antheridial nuclei in anaphases; 4, section of oögonium, showing nuclei in equatorial-plate stage and anaphases; 5, non-median section of oögonium, showing oösphere formation; 6, section of oögonium showing uninucleate oösphere and an antheridial tube, the latter discharging or about to discharge a nucleus into the periphery of the oösphere; 7, section of oögonium, showing an oösphere with male and female gamete nuclei in contact; 8, section of oösphere containing a fusion nucleus; two nucleoli visible; 9, section of oögonium containing two mature oöspores; large fusion nucleus visible in one.

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NEW OR NOTEWORTHY AGARICS FROM THE PACIFIC COAST STATES [1]

S. M. Zeller

The species described herewith are for the most part based on types collected by Dr. Gertrude S. Burlingham and which have been deposited in the Mycological Herbarium of Oregon State College. Included also are a few additional notes on better known species. Thanks are due Dr. D. P. Rogers for aid with the Latin diagnoses.

1. **Agaricus albolutescens** sp. nov.

Pileo e convexo subplano, 17.5 cm. lato, viscido glabro vel leviter fibrilloso-squamoso, albo flavescenti-maculato, siccitate toto flavido, margine integro veli fragmentis ornato; carne crassa alba flavescenti, grata sapore et odore; lamellis liberis, confertis, inaequalibus, circa 10 mm. crassis, "grayish pink," maturis fuligino-nigricantibus; stipite 5–9 cm. longo, 2–2.5 cm. crasso, basi incrassato, supra annulum innato-fibrilloso, infra leviter lacerato, firmo, supra leviter farcto, albido flavescenti; annulo supero, subtenui duplicique, infra squamoso, amplo, 1.5 cm. lato, albido, siccitate flavido; sporis ovoideis vel ellipsoideis, levibus, 5–6 (7) × 3.5–4.6 μ.

Solitarius vel gregarius, ad terram in silvis, prope oram maritimam, Oregon et California, Amer. bor.

Pileus up to 17.5 cm. broad, convex, expanding almost plane, glabrous when young becoming somewhat fibrous and floccose with torn up fibers, white staining amber yellow, becoming entirely yellow (light orange-yellow to amber-yellow) when dry, viscid when wet, edge projects slightly beyond the gills and sometimes with remains of veil attached; *flesh* thick, white, becoming yellowish, *odor* like anise or amygdalin, taste sweet and palatable; *gills* free, close, unequal, about 10 mm. broad at maturity, grayish-pink at first, becoming fuliginous to bone black; *stem* 5–9 cm. long, 2–2.5 cm. thick, bulbose base up to 4.5 cm. broad, innate parallel fibers above, somewhat lacerated below the annulus, firm, slightly stuffed above, whitish becoming yellow; *annulus* superior, rather thin and double, the lower layer breaking up into patches

[1] Published as Technical Paper No. 280, with the approval of the Director of the Oregon Agricultural Experiment Station. Contribution from the Department of Botany.

or scales, ample, up to 1.5 cm. broad, whitish becoming yellow; *spores* 5–6(7) × 3.5–4.6 μ, ovoid to ellipsoid, smooth.

Singly to gregarious, under conifers and oaks, Pacific seaboard of Oregon and California. November to February.

Agaricus albolutescens is in many respects similar to *A. arvensis* but they are easily distinguished both fresh and dry. The one outstanding contrast is in the color, especially when dry. There is some similarity to *A. flavitingens* Murrill, but the type of the latter is not available.

SPECIMENS EXAMINED:

Oregon: Lincoln county, Agate Beach, *Gertrude S. Burlingham, 27* November 21, 1934, type.

California: Monterey county, Pacific Grove, *G. S. Burlingham, 7–B* January 11, 1935; *4, 6* February 5, 1935; between Monterey and Salinas, *G. S. Burlingham, 3* January 18, 1935.

2. AGARICUS CROCODILINUS Murrill

Since this species was described (Mycologia **4**: 300. 1912) there has been no mention of this edible mushroom in literature. It is a common mushroom in the bottom lands around lakes in Klamath county in Oregon. September to November. It is a striking, enormous mushroom, ranging from 6 to 14 inches in diameter. The warts on the surface of the pileus, which Murrill described as "large gemmate," are pyramidal, or truncate pyramidal, 1.5–3 cm. broad and 1.0–1.5 cm. high.

3. **Agaricus glabrus** sp. nov.

Pileo e subconico expanso, subumbonato, 8–14 cm. lato, glabro, subnitente, centro "fawn" et "natal brown," margine "avellaneous," siccitate "wood brown" vel "army brown," fibrillis tenuiter innatis tecto; lamellis liberis, subconfertis, roseis vel brunneis, siccitate 'clove brown"; stipite subaequali, bulbo abrupto, glabro, infra leviter fibrilloso, albido, 6–14 cm. longo, 8–14 mm. crasso, cavo et farcto; annulo duplice, supra glabro vel striato, infra squamoso, lacerato, albido, persistente, amplo, 10 mm. lato; sporis purpureo-brunneis, basi oblique apiculatis, ovoideis, 5–6 × 3.5 μ.

Gregarius sub Querco, Pacific Grove, California, Amer. bor. Februario.

Pileus subconical then expanded, subumbonate, large; surface smooth, almost shining, avellaneous near margin, shading to fawn and natal brown at the center, drying wood brown to army brown,

densely covered with delicate, innate fibrils; gills free, rather close, pinkish becoming hair-brown, drying clove-brown; stem almost equal to tapering upward, abruptly bulbous, smooth, very slightly fibrillose below the annulus, whitish, 6–14 cm. long, 8–14 mm. in diameter, hollow or stuffed; annulus double, smooth or striate above, scaly and torn below, whitish, persistent, ample, 10 mm. broad; spores purplish brown, obliquely attached, ovoid, 5–6 $\times$ 3.5 μ. Suspected.

Gregarious under live oaks, at edge of woodlot, Pacific Grove, California, *Gertrude S. Burlingham, 18,* January 29, 1937; *11* February 1, 1937, type.

This species is reported poisonous, causing nausea, etc. when eaten raw and has a rather undesirable taste when cooked. One report, however, states that parboiling takes away the undesirable qualities. It is suspected and should be guarded against.

4. **Agaricus lilaceps** sp. nov.

Pileo ex hemisphaerico convexo expanso, 7–13 cm. lato, glabro vel leviter fibrilloso, "Hydrangea pink," ad marginem versus demum lilaceo-albido centro subcapriolo, tactu fulvescenti et ad marginem versus "light burnt umber," siccitate purpurescenti-cinnamomeo, cuticula separabili, margine sterili, veli fragmentis ornato, sapore et odore gratis paululo amygdalinis; lamellis liberis, confertis, ex albidis "pale flesh colored," dein lilacinis, maturis fuscentibus; stipite subaequali, leviter bulboso, 5–9.5 cm. longo, 1.5–3 cm. crasso, intus ex albo lutescenti, solido dein farcto vel leviter cavo, supra ex albo sublilacino, glabro vel leviter floccoso, infra horizontaliter rimoso fibrilloso, brunneo, basi tactu luteo-ochraceo, siccitate brunneolo; annulo albo, amplo, membranaceo, supero, evanescenti; sporis ovoideis, levibus, uniguttulatis, fuligineis, 4.5–7 $\times$ 3.2–3.8 μ

Gregarius vel caespitosus ad terram sub *Pino radiato,* Monterey county, California, Amer. bor.

Pileus 7–13 cm. broad, hemispheroid to convex-expanded, sometimes smooth, but usually somewhat fibrillose, short fibers on disc, rather long toward margin, Hydrangea pink (lilac t–1) fading to lilacy white toward the margin, tinted with chamois at disc, slowly staining tawny where bruised, and streaked with light burnt umber toward margin, drying a peculiar lilac with purplish tints to cinnamon or burnt umber with purplish shades, cuticle separable, margin projecting beyond the gills with some of veil hanging to edge; *gills* free, close whitish to pale flesh colored, becoming lilacy then fuscous; *stem* 5–9.5 cm. long, 1.5–3 cm. thick, subequal, slightly bulbous, white to creamy yellow within, usually solid, sometimes stuffed becoming slightly hollow, white to somewhat lilac and

smooth or minutely floccose above, horizontally torn and ridged below with light brown fibrils, yellow ochre stains at base, drying brownish without, fulvous with center paler within; *annulus* white, superior, narrow, drooping and adhering to stipe, finally evanescent; spores ovoid, 1-guttulate, smooth fuliginous, 4.5–7 × 3.2–3.8 μ; taste and odor pleasant, slightly of bitter almond.

Gregarious or caespitose, among grass under *Pinus radiata*, Monterey county, California. December to March.

Agaricus lilaceps is quite distinct in the lilac color of the cap, hence the specific name.

SPECIMENS EXAMINED:

California: Monterey county, Pacific Grove, *Gertrude S. Burlingham*, No. *19*, December 26, 1934; 1, February 12, 1935, type; and *2*, March 13, 1937.

5. AGARICUS PLACOMYCES Peck

Rather common in the borders of Douglas fir woods and also in mixed woods of western Oregon and Washington.

This mushroom is considered edible in the eastern and middle western states. The form which grows in western Oregon and Washington in every morphologic way seems to answer the description of the eastern mushroom, but on many occasions the western form has caused considerable poisoning. For more than fifteen years cases of poisoning attributed to this fungus have come to our attention. An odd circumstance is that one may be poisoned, but another who partakes as heartily may experience no ill effects. Three cases in Oregon during the autumn of 1937 were reported. The symptoms are not extreme. There is usually headache, and often nausea and diarrhea.

6. AGARICUS SILVATICUS (Schaeff.) Fries

The pileus of this species is usually described as "cinereous becoming yellowish-white with a rufous-fuscous disc, covered by brown scales." Such a plant is illustrated by Bresadola,[1] and typified by many observations and collections of it in western Oregon and Washington. On the other hand, Ricken[2] illustrates

[1] Bresadola, J. Iconographia Myc. *Pl. 830.*
[2] Ricken, A. Die Blätterpilze, *Pl. 62 f. 4.*

under the same name what to us appears to be an entirely different plant. Such discrepancies in literature are confusing, but it is more perplexing when two such come within the range of one's own experience. Dr. Burlingham sent several specimens which proved to be *A. silvaticus* (*sensu* Ricken) collected at or near Pacific Grove, California, from December 1934 to February, 1935. The caps were dark fawn to snuff brown (Report de Coul.) and otherwise similar to the fungus described by Ricken, except there is little if any change of the flesh when bruised or cut. The flesh is brownish drab under the surface. Ricken considers *A. haemorrhoidarius* as an autumnal form of his plant, but the California plant is not this species. It would seem that Fries (Epicrisis) did not have in mind the plant described by Ricken and that the gray form should be retained as *A. silvaticus*.

7. ARMILLARIA ROBUSTA (Alb. & Schw.) Fries, *sensu* Lange

Pileus 7–15 cm. broad, broadly convex to plane or margin somewhat turned upward and undulate at maturity, margin somewhat exceeding the gills; surface smooth to innate fibrillose, sometimes rimose in wet weather, viscid when wet, disc ochraceous tawny to buckthorn brown with xanthine orange spots, chamois to isabella color toward margin, with virid tints giving olivaceous tinges to general color; *flesh* white, thick at disc tapering to margin; *gills* about 1 cm. broad, slightly broader behind, whitish then ochraceous tawny at maturity, drying various shades of buff, darker where bruised, edge entire to wavy; *stem* cylindrical or tapering downward, 6–15 cm. long, 1.5–3.7 cm. in diameter, squamulose above, scaly below, scales becoming reddish to brick color, creamy staining reddish brown where bruised; *annulus* superior, fibrous-membranous; *spores* ellipsoid to ovoid, 1-guttulate, 6–7.5 × 3.7–5 μ, hyaline; *cystidia* none; sterile cells on edge of gills clavate, not distinctive; odor of cucumber.

Single or gregarious under conifers. Western Oregon and Washington. October and November.

In the coastal regions this grows under the same conditions as *A. ponderosa*. It is one of the largest species of *Armillaria* and in all literature available on the species is inadequately and incorrectly described. The virid tints of the cap are most always present, but never mentioned in descriptions. A complete description is given here and Lange's illustration (tab. 16 C)[3] is

[3] Lange, J. E. Flora Agaricina Danica. Copenhagen. 1935.

correct for color so far as the Pacific Coast specimens are concerned. The writer had it named as new in Herb. for several years, but Lange's illustration has caused me to refer it to *A. robusta.*

8. **Lepiota atrodisca** sp. nov.

Pileo e subconico-hemisphaerico plano-expanso, umbonato, 2–5.5 cm. lato, umbone squamuloso, primo "mouse-gray," denique "sooty-black," superficie cetera subalbida inter squamulos atros imbricatos fibrillosos, margine fere striato denique cuticula radiatim rimosa; carne alba, tenui, immutata, grata sapore et inodore; lamellis liberis, ventricosis, albis, 3–5 mm. crassis, acie minute serrulatis, in margine cystidiis clavatis praeditis; stipite gracili, 3–5 mm. × 5–12 cm., subaequali, glabro, albo, denique sordido, cavo vel fibrillis farcto; annulo superiore, persistente, supra albo, infra brunneo, sed atro-marginato, membranaceo; sporis ellipsoideo-ovoideis, levibus, 7 × 4 μ.

Gregaria, ad terram in silvis densis coniferis, Alsea, Oregon Amer. bor.

Pileus 2–5.5 cm. broad, hemispheric, subconic to plano-expanded, umbonate, umbo squamulose, "mouse gray" in young specimens, becoming finally "sooty black," surface breaking into small fibrillose scale, concolorous with the umbo, giving a general smoke gray color because of the almost white surface between; margin sometimes almost striate, cuticle slightly splitting and receding at margin; flesh white, unchanging, thin; taste pleasant, odor none; gills free ventricose, 3–5 mm. broad, edges slightly serrate; stem slender, 3–5 mm. × 5–12 cm., equal to somewhat smaller above, smooth, white, finally sordid where touched, inside white, hollow stuffed with fibrils; annulus membranous, white above, brownish below with a blackish margin, superior, persistent; *spores* white in mass, ellipsoid-ovoid, smooth, 7 × 4 μ; cystidia on edge of gills clavate, not particularly characteristic.

Gregarious on side hills in rather dense forest of *Pseudotsuga taxifolia* with a few *Corylus* bushes near, Alsea Valley. November 13, 1934. Collected by *Gertrude S. Burlingham* and *S. M. Zeller* (O. S. C. Herb. *No. 8997,* type).

9. **Lepiota oculata** Lange & Zeller, sp. nov.

Pileo 1.2–1.8 cm. lato, e convexo subplano-expanso, leviter umbonato, submembranaceo; superficie cetera alba, cericea-fibrillosa inter squamulos densos rubello-brunneos piloso-fibrillosos, constituentes prope umbonem cuticulam subcontinuam; margine menbranaceo, fimbriatulo et leviter rimoso; lamellis liberis, confertis, angustis, albis, in margine cellis capillaribus vel subcapitatis (apicibus circa 5 μ crassis) praeditis; stipite albo, 3.5 cm. × 1.5–2 mm., subglabro, super annulum leviter floccoso; annulo albo, superiore,

persistente, leviter infundibuliformi; sporis ovoideis, albis, levibus, 6–7.5 × 3.2–3.6 μ.

In silvis densis mixtis, prope Hemlock, Tillamook county, Oregon, Amer. bor. (*J. E. Lange* et *S. M. Zeller*).

Pileus 1.2–1.8 cm. in diam. convex, expanding almost plane, with a small, slightly prominent umbo, almost membranous, especially toward the margin; surface silky-fibrillose with delicate pilose-fibrillose squamules, which are dense and reddish-brown, forming an almost continuous cuticle at the umbo, and polar and even more minute toward the edge, where white tissue between the squamules is exposed; margin membranous slightly fringed and rimose; gills free, crowded, rather narrow, white; stem almost glabrous, slightly floccose above, white, 3.5 cm. ×1.5—2 mm.; annulus white, superior (about 2/3 up), somewhat funnel-shaped, distinct, persistent; spores ovoid, 6–7.5 × 3.2–3.6 μ, white, smooth; cells on edge of gills hair-like or subcapitate (apex about 5 μ in diam.).

In dense mixed woods near Hemlock, Tillamook County, Oregon, Sept. 27, 1931, *J. E. Lange & S. M. Zeller,* type (in Oregon State College Herb., *5726*).

The brownish-red umbo gives to this little *Lepiota* an eye-like appearance; hence, the name *L. oculata.* Its color is somewhat like that of *L. cristata.*

10. LEPIOTA CYGNEA Lange in Fl. Agar. Danica **1**: *tab. 13.*

In dense mixed woods of *Pseudotsuga Douglasii, Tsuga heterophylla, Alnus rubra,* and *Acer* spp., near Hemlock, Tillamook county, Oregon, September 27, 1931, *J. E. Lange & S. M. Zeller.*

11. **Naucoria cauralis** nov. nom.

Syn. *N. oregonensis* Zeller, Mycologia **25**: 385. 1933; *not N. oregonensis* (Murr.) Kauffm. Am. Jour. Bot. **13**: 28. 1926.

NOTES AND BRIEF ARTICLES

The Myxomycete Collection of The New York Botanical Garden

Until recently, the Myxomycete Herbarium at The New York Botanical Garden, while containing much valuable material from the Ellis Collection and others, was comparatively small. A few years ago Mr. Robert Hagelstein, a retired business man, who has for many years devoted his spare moments and recently almost his entire time to the collection and study of Myxomycetes, was persuaded to become Honorary Curator of this part of the herbarium at The New York Botanical Garden. Since that time he has continued to be a diligent and persistent collector and student of this interesting group of plants.

Recently he presented to the Garden his private herbarium estimated at 4800 specimens, the majority of which were personally collected by him and his associates in the states along the Atlantic Coast from Maine to Virginia, and in the West Indies. Among them also are about 1500 specimens from other parts of the world received in exchange. This was one of the largest private collections of Myxomycetes in this country.

Also, the Garden has recently acquired by purchase the private herbarium of nearly 3000 specimens, brought together by Dr. William C. Sturgis, the result of a lifetime of collection and study, and accompanied by his literature, notes, drawings, and correspondence with other students, covering a period of 40 years.

Both are rich in type material, rare species and varieties of unusual phases. The entire Myxomycete collection of the Garden now comprises more than 10,000 specimens and is probably the largest and finest in North America, and one of the most important in the world. This combined collection is available for study by any student of this group who wishes to consult it. There is a large amount of duplicate material, even of rare species, which is available for exchange with other institutions and students. To this end correspondence is invited.—Fred J. Seaver.

MYCOLOGICAL SOCIETY OF AMERICA

(WITH GROUP PHOTOGRAPH)

REPORT ON 1937 FORAY

The 1937 Summer Foray of the Mycological Society of America was held at Hanover, N. H., August 26–28. Laboratory facilities were supplied by Dr. A. H. Chivers and his able staff of the department of Botany of Dartmouth College, and to this group is due all the credit for a highly successful Foray. Adequate laboratory space for displaying the collections was available, and the facilities for drying the specimens have never been better. Comfortable sleeping quarters were provided in a College Dormitory in close proximity to the laboratory.

Although the preceding few weeks had been remarkably devoid of precipitation, rains fell over the preceding weekend and to some extent during the Foray, so that conditions for collecting were very good. A number of trips were made to collecting grounds in the vicinity of the town, and one day was spent at one of the famous Dartmouth Outing Club Cabins where we were royally entertained and heavily feasted. The group picture which accompanies this report of the meeting was made at this place. That day was, of course, the high-light of the Foray. The attendance at this function was well into the fifties. Another enjoyable occasion was the tea tendered the group by Dr. and Mrs. Chivers at 4:00 P.M. on Wednesday at their home.

One of the encouraging aspects of the Forays, at least to this writer, is the fact that each year seems to bring an increased interest in the more serious phase of collecting, studying, and exchanging views concerning the identity of collections made. I am quite sure that at no Foray of comparable size has there been a more serious attitude in this respect.

A business session was called on the morning of the 27th at which our President, Dr. Dearness, presided. Various and sundry items were discussed. One of these that invoked considerable comment was the invitation (tentative at the time) extended by Dr. Rene Pomerleau of Berthiersville, Quebec, for the Society to have its next Foray at his institution. The general sentiment

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expressed was that a Foray at some locality in Quebec or Ontario in the near future would be very desirable, and a considerable number of those present signified their expectations to attend such a gathering. Discussion of the question as to whether or not the last week in August was a more suitable date than any other for the holding of these forays brought forth the expression that such a period was more advisable than either an earlier or a later date. There was considerable discussion as to whether the entire list of fungi collected on the Foray should be published as was done last year, or whether a selected list of the more unusual collections made was the more desirable. A vote of those present showed that the selected list idea was the more acceptable. To the Vice-President was voted the duty of collecting such a list from the various individuals and preparing it for publication. After it was voted that the thanks of the Society should be extended to the local committee, and to the College for the able handling of the gathering and for the facilities placed at the disposal of the group, the meeting adjourned.

The Foray began to break up on Saturday, the last stragglers leaving early Sunday morning.

Among the fungi collected the following list contains those which have been designated by several interested specialists as being more or less noteworthy:

Myxomycetes: *Comatrichia Rispaudii* Hagels., *Fuligo septica* (L.) Weber (a green phase), *Margarita metallica* (Berk. & Br.) Lister, *Orcadella operculata* Wing., *Physarum penetrale* Rex, *Trichia alpina* (R. E. Fries) Meylan, *Trichia subfusca* Rex.

Ascomycetes: *Aleuria rhenana* Fuckel, *Aleurina retiderma* (Cooke) Seaver, *Calycina macrospora* (Peck.) Seaver, *Chlorosplenium aeruginascens* (Nyl.) Karst., *Cudonia lutea* (Peck) Sacc., *Geoglossum glabrum* Pers., *Helotium herbarum* var. *Rubi* Ellis & Ev., *Lachnea albospadicea* (Grev.) Phill., *Hypomyces Lactifluorum* (Schw.) Tul., *Lamprospora Crec'hqueraultii* (Crouan) Boud., *Lamprospora trachycarpa* (Curr.) Seaver, *Macropodia macropus* (Pers.) Fuckel, *Microglossum rufum* (Schw.) Underw., *Onygena equina* (Willd.) Pers., *Orbilia xanthostigma* Fries, *Peckiella lateritia* (Fries) Maire, *Pezicula Rubi* (Lib.) *Pezizella hyalina* (Pers.) Rehm, *Propolis faginea* (Schrad.) Karst., *Psilopeziza hydrophila* (Peck) Seaver, *Spathularia velutipes* Cooke & Farlow, *Sphaerospora brunnea* (Alb. & Schw.) Massee, *Trichoglossum Walteri* (Berk.) Durand, *Tympanis conspersa* Fries, *Ciboria* sp. on leaf petioles, close to *C. luteovirescens* Rob. & Desm., but differing in larger asci and different spores.

Basidiomycetes: *Agaricus diminutivus* Peck, *Boletus Atkinsonii* Peck, *Boletus eximius* Peck, *Boletus leucophaeus* Pers., *Boletus placidus* Bon., *Boletus rubeus* Frost, *Boletus scabripes* Peck?, *Boletus speciosus* Frost, *Boletus variipes* Peck, *Clitocybe ectypoides* Peck, *Hydnum alboniger* Peck, *Hydnum Scheidermayeri* Heuffl., *Physalacria inflata* Peck, *Polyporus immitis* Peck, *Polyporus fagicolus* Murrill, *Stereum radiatum* Peck.—L. O. OVERHOLTS.

In the recent article by Ralph Emerson on "A New Life Cycle Involving Cyst-Formation in Allomyces" in Mycologia **30**: 120–132, the following errata should be noted:

Page 124, line 20: Insert "of" after "papilla."

Page 124, line 26: Change "Fig. 10, D" to "Fig. 10C."

Page 124, line 27: Insert "from cysts" after "emerged."

Page 129, line 4 of (2) under Cystogenes: Insert "sporangia which liberate" after "small."